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THE
SMOKE NUISANCE,

AND

ITS REMEDY
BY MEANS OF WATER.

WITH REMARKS ON LIQUID FUEL.

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CONSULTING ENGINEER FOR THE WARMING AND VENTILATION OF BUILDINGS,
AND THE CONSTRUCTION OF PETROLEUM FURNACES.

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PREFACE.

Architects have often been blamed for not inventing a better system of flue construction than that at present in use, not only for the prevention of smoke in our dwellings, but for the hindrance of its presence in the atmosphere. Several attempts, and most excellent ones, have been made for the former, very few for the latter, which is one of far greater difficulty. A model was exhibited in the Exhibition of 1852 of a method by which the smoke and soot could be taken to the sewer, but it was founded on the assumption that the sewer would act as an exhaust, which it could not, being well supplied with ventilators which permit its odours to ascend into our streets. Whatever the merits may be of the plan here proposed, it will require good professional attention to carry it out, and the writer expects, if it should be entertained, to have only a fair share of the practice arising therefrom.

C. J. RICHARDSON,

21, Carlisle Terrace,
Kensington, W.

March, 1869.

THE SMOKE NUISANCE,

AND

ITS REMEDY.

CHAPTER I.

ON THE SMOKE NUISANCE, AND ITS REMEDY.

The Act of Parliament, passed in 1854, to abate the nuisance arising from the smoke of furnaces in the metropolis and from steam vessels above London Bridge, has been admitted by the best authorities to have been productive of very great benefit, more particularly in that portion of London where the atmosphere was filled with the dense smoke issuing from factory chimneys, mostly on the south side of the Thames. The prevention of smoke from the chimney of the domestic hearth, which is really the chief offender, appeared, or was assumed, it must be supposed, to be an impossibility, and that was left untouched.

It was known previous to the passing of the Act that an easy remedy existed which could be applied to common furnaces, one which while it caused a saving of fuel, permitted the almost entire prevention of heavy black smoke; indeed by many of the manufacturers, this remedy had been adopted before the Act appeared. It was by careful firing only, combined with alterations of a simple and inexpensive kind, chiefly to regulate the admission of air to the flame. The consumption of smoke by the ordinary river steamboats and steamtugs was perfectly practicable by methods similar in principle to those which are used in land furnaces.

It is only in the large steamers and vessels of war, whose powerful engines require a large amount of steam, and where rapid firing is the rule, that the simple remedies applied to our smaller furnaces become nearly impossible. In 1865 even the *Great Eastern* found herself in want of steam through having removed two of the boilers to make room for the Atlantic cable; it was noticed in the public prints as being the primary cause of the loss of the cable. In fact, for all these Leviathan steamships a stronger fuel than coal is becoming necessary; they have indeed a superior method of destroying smoke by a blast of super-heated steam thrown on the flame, but it requires a large amount of what cannot be spared, especially with coal as fuel.

When the writer of this paper was conducting his experiments at Woolwich Dockyard with liquid fuel, coal was tried against it. A large boiler belonging to the gunboat *Teazer* was kept in full action for two days; the engineer's return showed, in the first day, with moderate slow firing, 32,096 lbs. of water evaporation by 4260 lbs. of coal, at the rate of 7·53 lbs. of water per 1 lb. of coal, with very little smoke:—on the second day, with rapid firing, 39,648 lbs. of water was evaporated by 6000 lbs. of coal, at the rate of 6·608 lbs. of water per 1 lb. of coal, this time with dense smoke. The very best hand-picked coal in large lumps only was used. It may be imagined therefore, with such a poor result as an evaporation of barely 6¾ lbs. of water per 1 lb. of Welsh coal, what an immense amount of such fuel is necessary to be carried by our monster ironclads and large packet ships, the large quantity used, and the impossibility of preventing black smoke.

The preventive remedies applied to close furnaces cannot be adapted to the open fireplace; closed stoves might be used, such as Dr. Arnott's. But we have excellent means of heating in the various warm water systems, by which an extensive building may be completely warmed in all its floors by a smokeless furnace in the basement. In the year 1837, the writer published a small volume descriptive of Mr. Perkins' system of doing this; many of the furnaces there described are still at work and in good order. We could use the German stove; fifty years ago it was introduced very extensively into England, and occasionally one may still be seen, standing useless in the passages and halls of our public offices.

Dr. Arnott's stove has been applied to the common fireplace and used very extensively; but like all smoke consuming stoves it does not make a good companionable fire, and that is an objection. The common open fireplace has held its own, and will continue to hold its own against the best contrived stove that can be introduced in lieu of it. But it still remains to receive such a construction as will remedy its serious defects; these are chiefly such as pertain to the flue, it is not the stove, for that, thanks to our excellent makers, is quite perfect.

The *Times*, in a powerful article (only one of many) on the smoke from the common stove (Jan. 1855), tells us: "Smoke we have always with us. If we look out on a fine summer's day through the louvre boards at the top of the Crystal Palace for a view of the great Metropolis, we naturally exclaim, 'I see it—there is the smoke!' Indeed any picture of London without its dark canopy of soot, would be unrecognisable; it is the black and heavy cloud arising from the 400,000 houses of London. In it we behold the great aerial coal-field, which contains annually no less than 200,000 tons of fuel which escape from us up our chimneys. Escape, did we say? O that it did, and that we never heard or saw more of it; but smoke, like a chicken, still returns to roost. We do not allude to those horrid blacks that dance and waltz before our very eyes, and then maliciously plump down upon the ample page of some fine edition, or squat deliberately upon the most delicate distance of a sketch by Copley Fielding, but to those finer blacklets that invisibly permeate the air. If we look at any fracture through which a draught penetrates, a cracked window, or a shrunken skirting-board, we shall find that the edges are ragged with a fine fringe of soot, pointing towards the fireplace. This fact alone is enough to demonstrate that the air is charged both inside and outside our houses with a vast amount of infinitely divided carbon. If it is deposited in this manner by the mere friction of passing any object, we may imagine what irritation it must occasion to the human lungs into which it is sucked 30 times in a minute, converting them as it were into a temporary coal-skuttle, out of which we are perpetually compelled to throw the obnoxious intruder with a cough."

Considering that London contains about 400,000 houses, and that the average number of flues to each house may be given as five, making 2,000,000 chimneys, half of which may be supposed to be at work during winter, while always 400,000 kitchen chimneys are in full action during summer, the only wonder is that the atmosphere of London should be so pure and fresh as it is. The black mist cannot be considered, however, altogether as an evil; it at least makes good for trade, and that to an enormous extent. It benefits all the architects and builders in the first place, by the continual erection of houses; likewise the lawyers, in preparing leases and mortgages; it entirely supports the omnibus traffic, and is of material assistance to the railroads, and all the thousands of tradesmen who sell soap, candles, dress, ironmongery &c. &c.

In the centre of London the houses are packed very closely together. Half the cook-shops, half the hotels and eating-houses are there; every room is an office, and each one has a fireplace in it, and certainly at times, the smoke there is rather dense, but not a bit more than a genuine Londoner cares for. He has a notion that the blacks or blacklets he takes in with his breath, are not to a strong man altogether unwholesome; they make him enjoy with greater pleasure the country air at his villa, where the more delicate of his family, the ladies and children, reside. They would probably prefer a handsome line of well-filled shops to the prettiest line of hedge in the country,—but the blacks of London stop at least all comfortable shopping. As soon as business hours have closed in the city, merchants and clerks all alike hurry off to seek a little purer air in the outskirts, a little further and further, until over and over again the suburbs become as foul as the town. London is now said to have a diameter of 50 miles; all the building-land surrounding it obtains a fabulous rental. In the very tip-top positions 750*l.* per acre is paid; in the immediate country districts about 40*l.* an acre; when the leases expire and the rack rental of all the buildings on the land falls in, there are fabulous incomes for the owners. Nothing can check the extension of London while its atmosphere remains in its present state. Probably when the utmost limit of railway carrying has been reached, and the diameter of London is 100 miles, and it is understood that travelling 50 miles twice a day at a pace of 50 miles per hour is detrimental to health and long life, some check may be given to it. But the chimney-flue which sends out such impure smoke is an evil in the country as well as in the town—of course to a far less extent; and it is very desirable that a construction to stop this smoke should be applied to it. The *Times*, at the end of the powerful article already quoted, puts the question—"Can we put out the smoke of the domestic hearth?"

The writer believes that we can, and that in a very simple way; but to do it efficiently no mere doctoring of the flue will suffice, it must be subjected to, as it were, a bold surgical operation.

The blacks are good things, at present in their wrong place; they could very easily be got rid of, and if it were possible to cut into all the chimneys of London and apply the remedy, the whole of the soot, which at present escapes into the atmosphere, might be caught, and passed into the drains;—it would there deodorise them, and the sewage when it arrived at the Abbey-mills would be rendered doubly valuable as manure and be largely increased in quantity. It is certainly not possible, from the Herculean nature of the task, to disturb the whole of the chimneys of London, but the worst only might be operated upon, such as the chief kitchen flues of the great establishments, which are continually sending out black inky smoke.

The writer's remedy is to pass smoke through a water spray. A few years ago he had a stove and flue erected in his garden, to try the effect of water upon smoke. Becoming interested in the matter, on the success of his trial, he went to the Patent Office to see if any previous attempts had been made,—and found that as far as his idea only was concerned, several parties had been before him, but no information was given as to the way in which they operated.

In 1852 Mr. Chaplin took out a patent for subjecting smoke in chimney-flues to the purifying action of water, by which jets or showers of water were made to play within the chimney, or in a chamber connected with it; the smoke or vapour passed through the water, by which it was condensed, and all the heavy matters and impurities were carried off through passages fitted to receive and retain them. This patent was, however, only a repetition of one granted thirty-eight years previously, to the well-known Frederick Muntz of Birmingham, who described his method as one for nearly destroying smoke, and obtaining a valuable product therefrom. Mr. Muntz passed the smoke through a quantity of water, either cold or warm, before it escaped into the atmosphere; and by that means, all the blacks and earthy substances contained in the smoke, were thrown down and precipitated, or swam on the surface of the water and were collected as it ran away. He gave a general description, so as to include every possible way in which it might be done. He preferred an horizontal flue, with a copper top perforated with holes, the top constantly covered with water 2 or 3 inches deep. He said the same effect may be produced by jets of water from the bottom or side of the flue, or in any other way by which the water shall pass through the smoke. He preferred the shower-bath method, and suggested air pumps, air dips or ventilators and bellows, to create a draught. How the construction of all this, or of any part of it, was to be carried out, was not shown—no drawing of any kind was given, either by Mr. Muntz or Mr. Chaplin, and the patents were useless.

Now it appears quite certain that smoke could and would be purified by passing through water. The idea was tangible, it was one that "any fellow could understand;" but then, how was it to be done within a flue?—and that flue a vertical one, half a brick only on each side from two others. Before showing a simple way of performing it, it is well that the reader should be acquainted with the form of the house-flue which is required to be operated upon.

In our London houses it may be said we have two kinds of flues, the old fashioned one, of a section of 14 by 9 inches, made originally that size for the accommodation of the poor sweeping boys, and the flue known as Cubitt's flue, which has a diameter each way of 9 inches. Mr. Cubitt left the kitchen flue alone the old-fashioned size.

The writer favours the small flue, and always uses it in his buildings. There are many persons who still maintain that the old-fashioned flue is the correct one, and it is still almost universally used. Now there is an old saying about the proof of the pudding. In Belgrave Square, all the first houses designed and erected there have the old-fashioned flue, and there is scarcely a dozen of the old chimney-pots left; all have been changed for tall-boys and other similar contrivances; one house alone has about 24 in one stack. No. 49, built by Cubitt about 35 years ago, and having the descending or Cubitt's flue, has the stacks exactly as at first constructed, with the exception only of a little doctoring to the kitchen flue. In the house opposite, No. 48, one of the first, the external stack alone, next the street, has no less than 17 tall-boys, two of which appear to be broken off. On the opposite side of the Square, in Chesham-place, is No. 38, by Cubitt, built about 30 years; it has all the original stacks untouched. The Cubitt flue can be seen by the small peculiar cap on the chimney-pot, and several stacks remain in their original state. In Eaton-place and Eccleston Square, where the same flue is used, the roofs tell the same story. In the first buildings erected by the present writer he used the large flue, and he now finds several specimens of chimney-doctoring on the roofs. In some large houses he lately erected at Queen's Gate, in which the Cubitt flue is used, there are several houses together without any disfigurement at all on the roof; indeed he should consider that the appearance of a tall-boy on one of them would be rather a proof that there was something wrong about the servants' management of the fires, than there being anything wrong in the construction of his flues. As no representation of the Cubitt flue has ever been published, it is here given. Fig. 1 represents a portion of the chimney-flue construction of a first-rate house, the lower chimney opening is in the basement, and above it are two others, one in the ground floor, and one in the first floor. It will be seen there are three flues descending or taken down to the basement; the third flue belongs to the room on the second floor, the wall is two bricks thick, the flue, 9 inches in diameter, contained within the wall with no chimneybreast projecting. Fig. 2 in fig. 1 is a plan of the flues on the ground floor, and fig. 3 of those at the first floor. Fig. 4 is a section of the fireplace opening; this is 3 feet in height from the floor-line, the brickwork at top splayed and supported by an iron bar; these openings are always filled up with 4½ straight joint work, to be taken out when the mantelpiece is fixed. Fig. 5 is the chimneypot and its cap, the latter opening at top 7 inches by 6 inches only; fig. 6 shows one of the sweeping doors, of which there are two to each descending flue; the latter three figures are

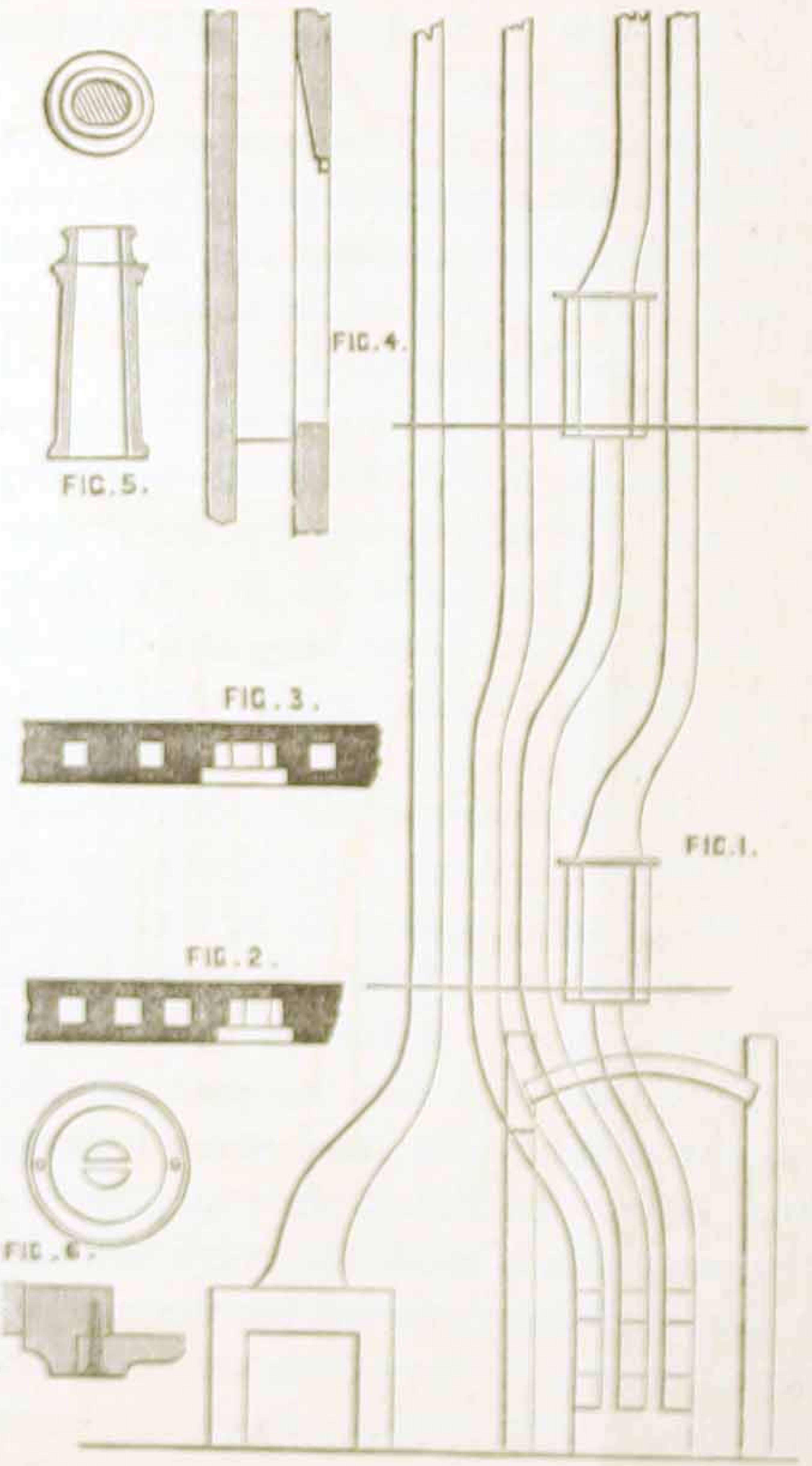


Fig. 1.

twice the scale of the former. A plan and section of the chimney complete, with its marble mantel and stove, is given in figs. 2 and 3. The flue passes complete at the back of the stove, the lower part of it is closed by an iron plate to a height of 2 feet, on this is fixed the moveable door or register, shut fully or partly over the flue when the stove is in use, closed over the stove when the flue has to be swept. The arrows show the admission of air to the front of the fire, brought through the floor, and two openings in the back hearth from the outside of the house (this contrivance is intended to be kept concealed).

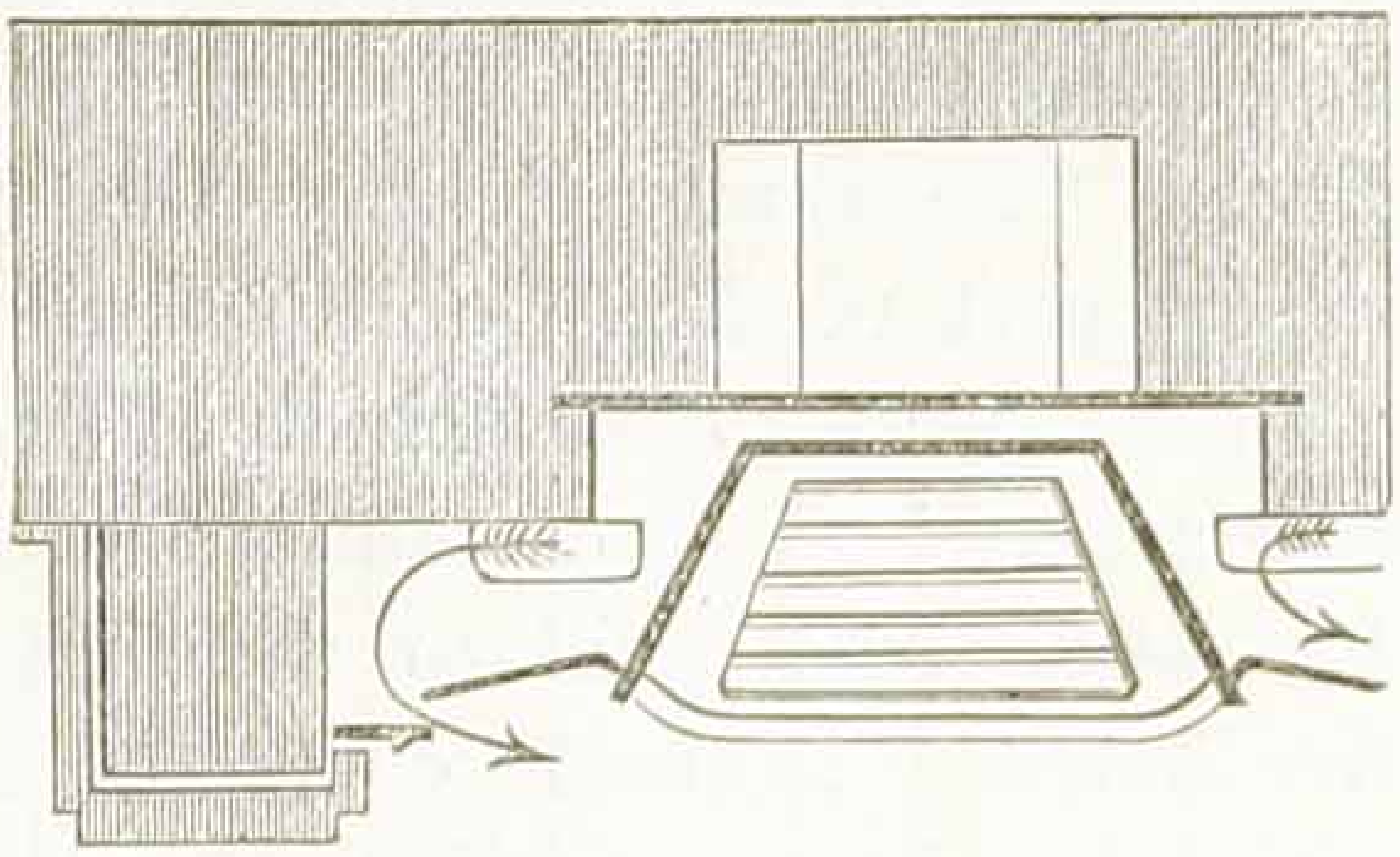


FIG. 2.

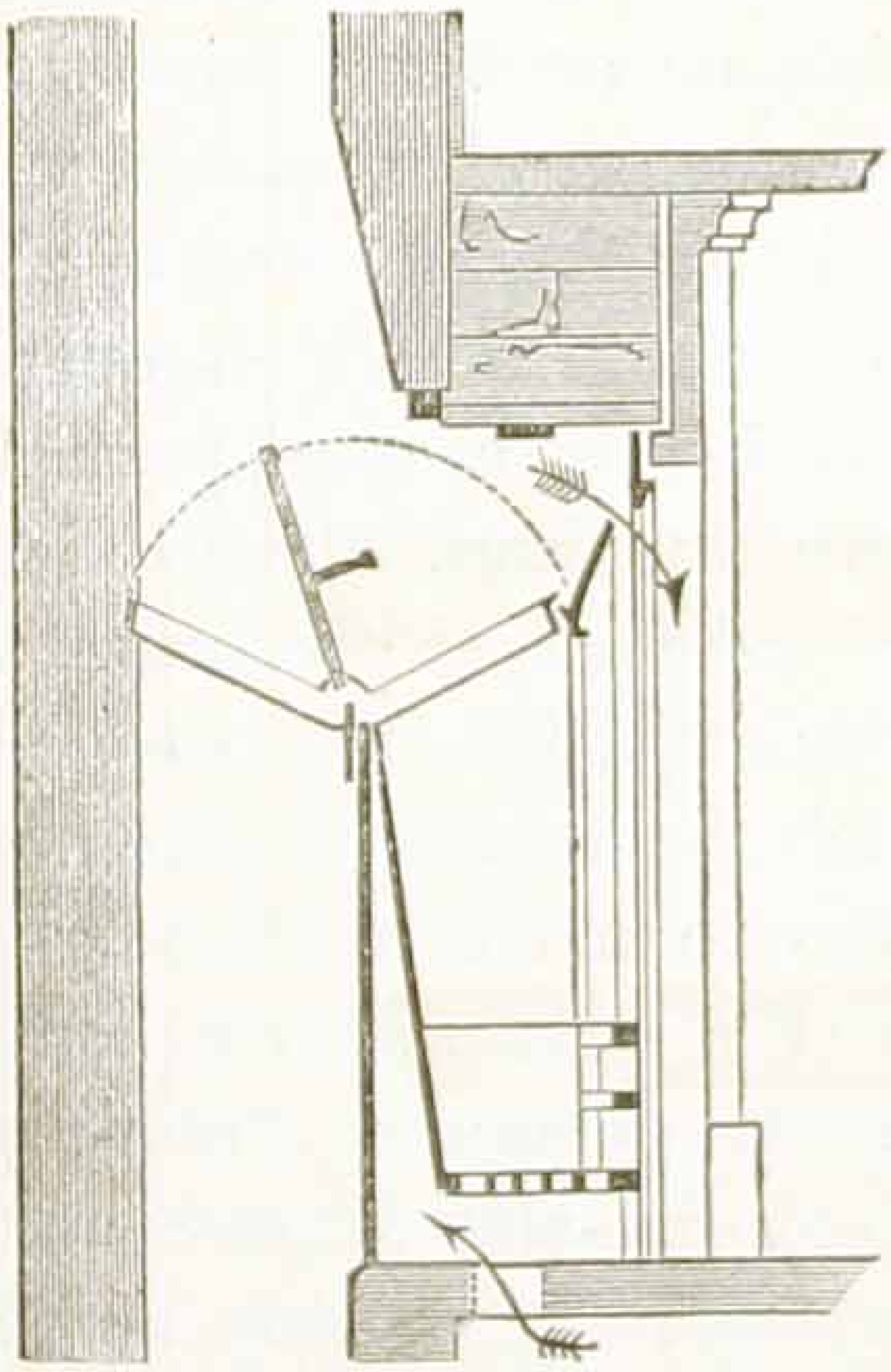


FIG. 3.

Fig. 4 shows the method for admitting air above the architrave of the entrance door of the room. The opening is made about 2 feet in length; this, after a little time, becomes marked by the blacks coming in from the passage. The flue, when the fire is lighted, becomes very hot, the smoke ascends speedily and soon leaves it. The flue requires the stove to be formed expressly for it. Mr. Cubitt made the stoves only for his own houses, and the writer, at Queen's Gate, had some difficulty in procuring stoves of the right pattern, for manufacturers like their own shop patterns to be preferred, and some of these would have covered up half the descending flue; those he used

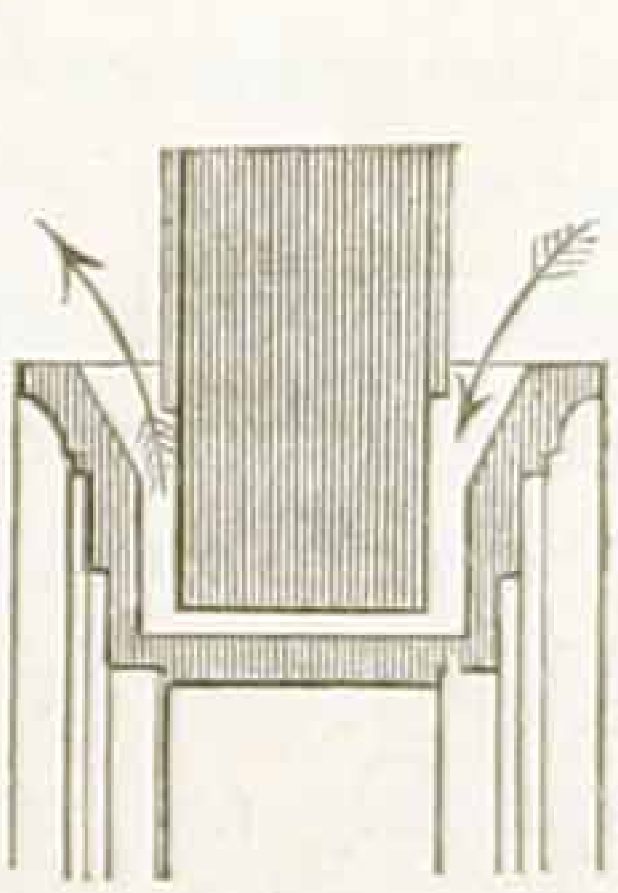


FIG. 4.

were supplied by Messrs. Feetham of Clifford-street, to whom the flue and stove were well known. The flue is considered an excellent one; it is a builder's flue constructed solely of brick, and it certainly is the best of the brick flues. The same attention was paid to it as was given to every part of Mr. Cubitt's buildings. It may be asked, "Are there no other kinds of flues constructed of superior materials?" Yes, certainly there are; particular attention has often been paid to the flue. There is Hiort's circular flue, formed in each course of four wedge-formed bricks, which has been extensively used in some of the Government buildings and the houses in Carlton Gardens: it did not bind well with the brickwork, so we have Mr. Moon's improvement upon it. We have Seth Smith's metallic chimney lining, an excellent flue; the lining, a pipe of about 9 inches in diameter, when placed within a larger brick flue, renders the latter the best one of all for ventilation. It warms the brick flue, into which openings can be made from every room in its upward passage to an open ventilating-brick above the roof. There is Denley's descending flue, constructed with earthenware tubes or pipes, and very similar to Cubitt's, but not so good. We have Boyd's flue, in which the withes between the flues are formed with iron plates to make ventilating passages; Doulton's flue, which does the same with earthenware tubing. It is well known that the common drain-pipes make good flues, likewise glazed fire-clay pipes; such flues are easily swept, pass away the smoke very quickly, and seldom smoke at the wrong end. If it is asked why these are not more used, the answer simply is that the houses of London are constructed chiefly by speculative builders on borrowed capital. As soon as the roof is on and the carcase completed, the original lease is granted, upon which a large sum or "draw" as it is called, can be easily obtained. Now, anything that prevents this desirable result from happening as quickly as possible, meets with the most determined opposition from the builder, and there could be nothing more certain to cause delay than any one interfering with his brickwork, giving his workmen anything to stop for and to consider about, or to handle any material in addition to the well-known brick; hence it is the public still have the common vulgar flue, which, on the least puff of wind outside, sends the smoke into the room, requires its stove to be made into a small furnace to give its chief heat to the flue, and a tall-boy to be placed on its top to lessen its size and improve the draught. The small-sized flue of course warms more effectually. An enthusiastic admirer of the Cubitt flue once told the writer that with a good fire in the grate, if a kettle of water could be placed on the top of the chimney-cap, the water would soon boil, even if the flue was fifty feet high. The flues constructed of metallic or earthenware casings retain the heat longer, and are still hotter than the Cubitt flue. It may be imagined, from our hot flues, that the temperature of London is always some degrees higher than that of the country. In winter snow may be seen in the suburban fields, but none in the town. To conclude with these flues:—the better the flue, the more blacks it sends out; the Constructor has thought more of that "delicate distance" of a sketch by Copley Fielding, or the ample page of some fine edition in the library of the mansion, than he did of the quart-measures of blacks which at any time can be collected from the roof.

We may be assured that not one of any of our present flues can effect, in the very slightest degree, any purification of the smoke, or retain the blacks for any useful purpose; and it is of no use disguising to ourselves that any contrivance or appliance, to effect either of these most desirable objects, must form an additional construction to the flue, to be attended with additional expense, requiring extra attention. Therefore any such appliance, if introduced, should be effectual, to repay such additional cost to its owner, by a saving, or at least a more economical use of fuel.

The appliance to the flue the writer has to recommend, he considers will not only cause an economical use of the fuel by not permitting the present waste of heat, but will purify the smoke, and retain the blacks for any useful purpose to which they can be applied.

Fig. 5 represents a section of a small stove, with its flue experimented upon by the writer to ascertain the worth of the water-spray process. The lower part of the stove is of brick, the upper part, with the cistern, is of zinc; *a* is the fireplace, *b* the cistern of water, and *c* the soot receptacle. The coal fire was lighted, and as soon as dark smoke appeared at the chimney top, the water-valve was lifted, and about 16 fine jets of water were sprayed against a piece of loose perforated zinc, suspended in the flue as shown in the figure; the smoke had to turn towards the water, and to pass through it to get to the flue above. On the instant the water was applied, the smoke appeared at the chimney top of a light colour, and it came out at the soot receptacle nearly as much as it did at the top, and of a similar light vapourish character—a sure sign that it was drawn down by the current of water. Soot in a large quantity was soon seen in the receptacle; two small pieces of glass were placed in the flue, that the operation of the water might be observed.

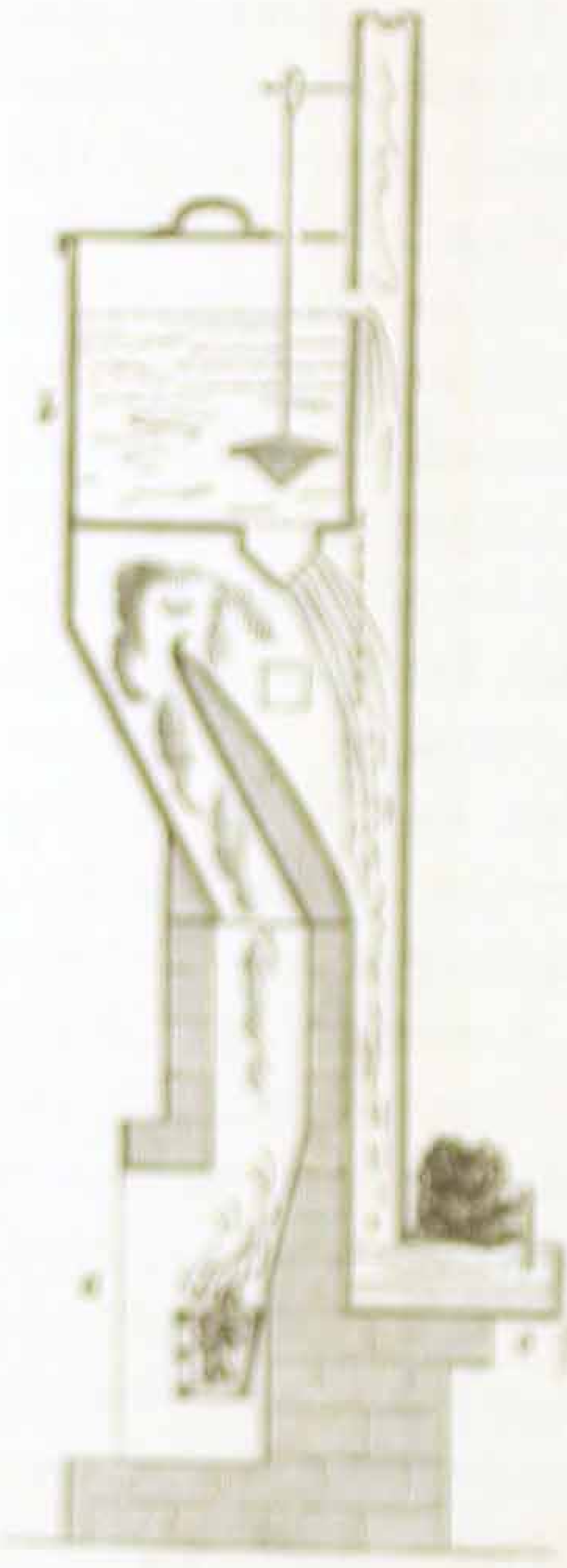


Fig. 5.

The stove was kept in action at various times for a few months, and always with the same result. If the descending soot-flue had been 30 or 40 feet in length instead of only 4 or 5, less vapour would have escaped below; it was evident that the operation purified the smoke.

The adaptation of this simple contrivance to any kind of the domestic chimney-flue is not a very difficult operation. It is only necessary to take out the brickwork in front of a flue for a height of 4 or 5 feet, then introduce a cast-iron flue (*d*, fig. 6), gathering up the brick flue beneath; a second iron flue, *e*, shaped like a funnel, is placed behind the first, to collect the soot and water, and pass it off through the pipe *h*. The cistern is placed partly within the wall and partly covering the two flues, and a moveable decorated pedestal *b*, Fig. 7, covers and conceals the whole. It is not at all necessary that the cistern should

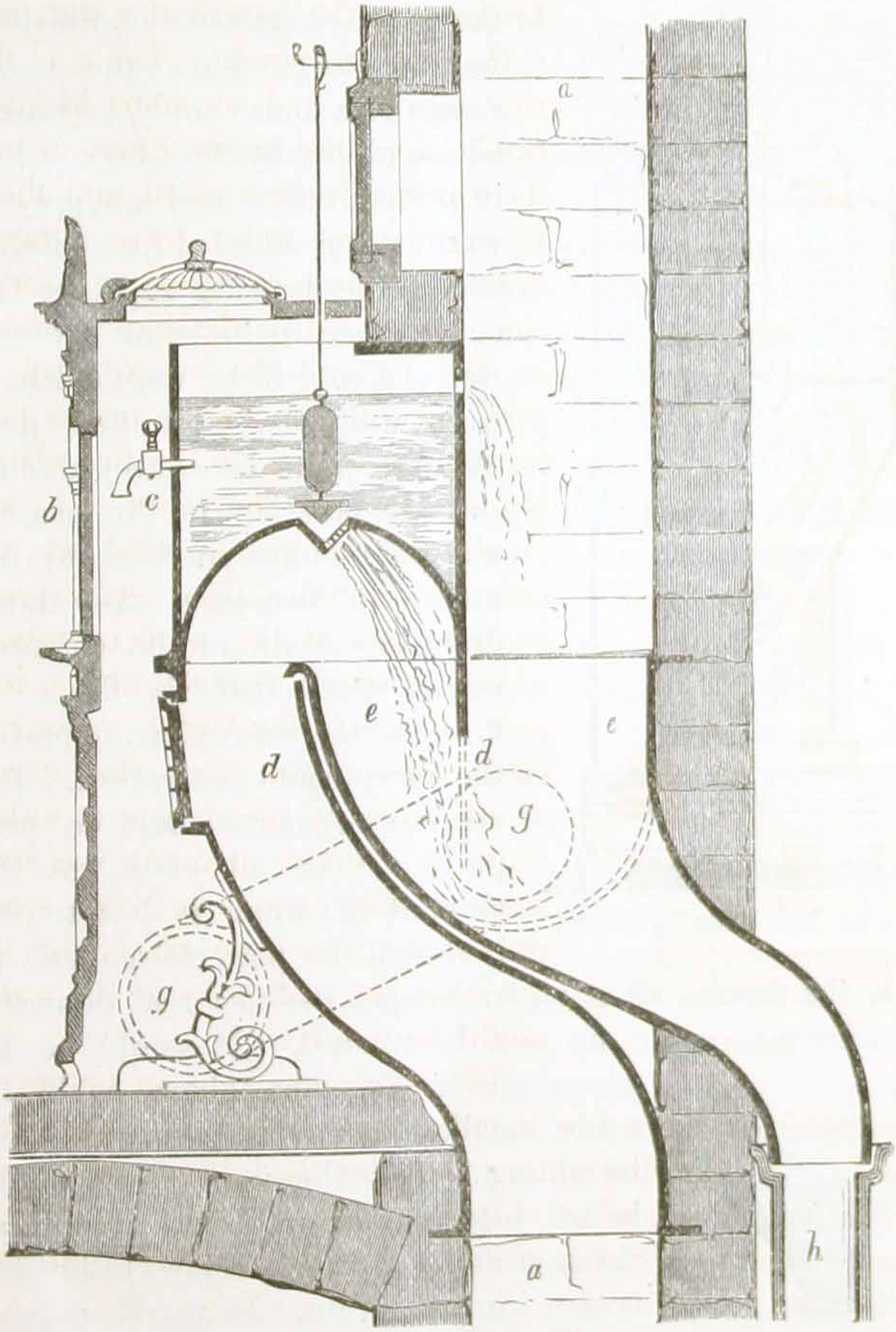


Fig. 6.

supply the spray; that might be done by a separate pipe, with a tap to turn off and on, as desirable. The water in the cistern would soon warm, and the pedestal would be the means of affording heat to the room or passage in which it was placed. Thus the upper rooms of a house could be warmed or aired by the fires below in perfect safety, and a supply of warm water afforded for domestic use. The drawing supposes the contrivance to be in an external wall; should it be required in a party wall, the soot flue goes off at *g, g,* to be conveyed outside the building in the nearest way; doors are provided for the purpose of sweeping. Any down draught of air in the chimney might spend itself in the soot-flue, and the smoke having passed the spray could not return. The current of water must be proportioned in all cases to the amount of work it has to do, it should be powerful enough to draw the smoke after it, to compel it—this real domestic nuisance—to come up and be washed. It would be an advantage if the flue above could be made smaller; a way for doing this will be shown. But the upper flues might be led into one general flue, as well as the soot and water-flues below, before entrance into the drain. It would require another sort of drain-eye to the sewer, different to that at present in use, the lid or flap of which opens from the top. Fig. 8 shows the kind of drain-eye that would be required.

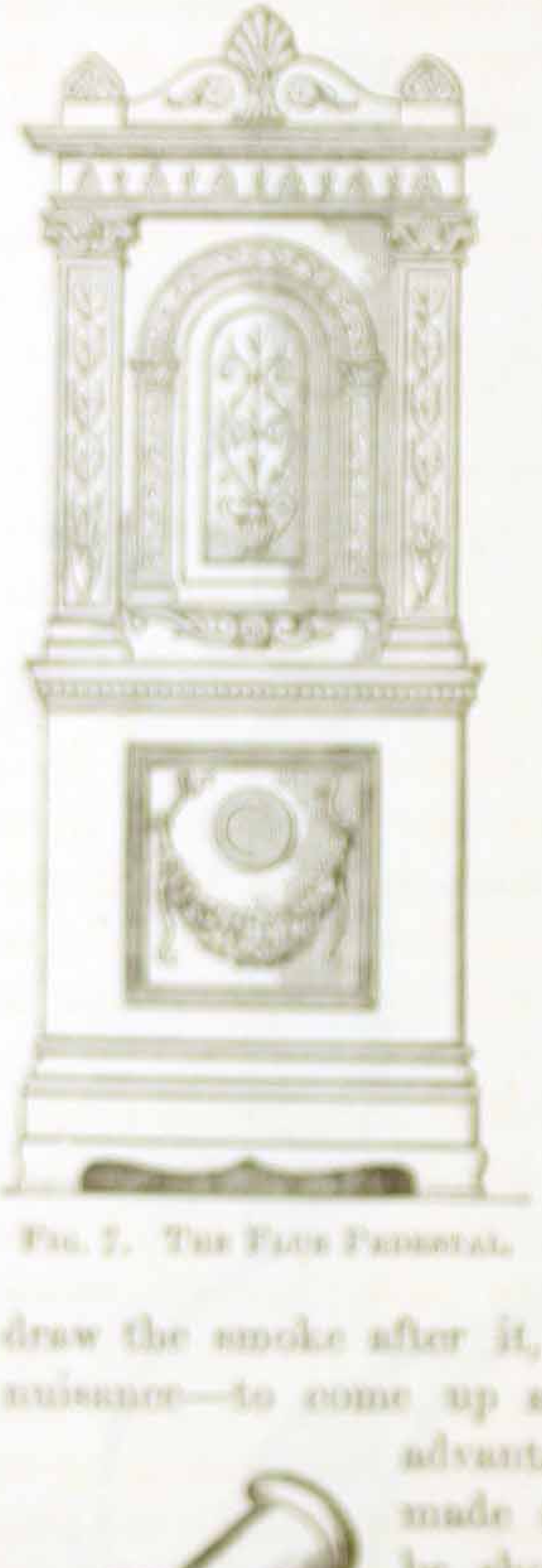


FIG. 7. THE FLUE PEDESTAL.

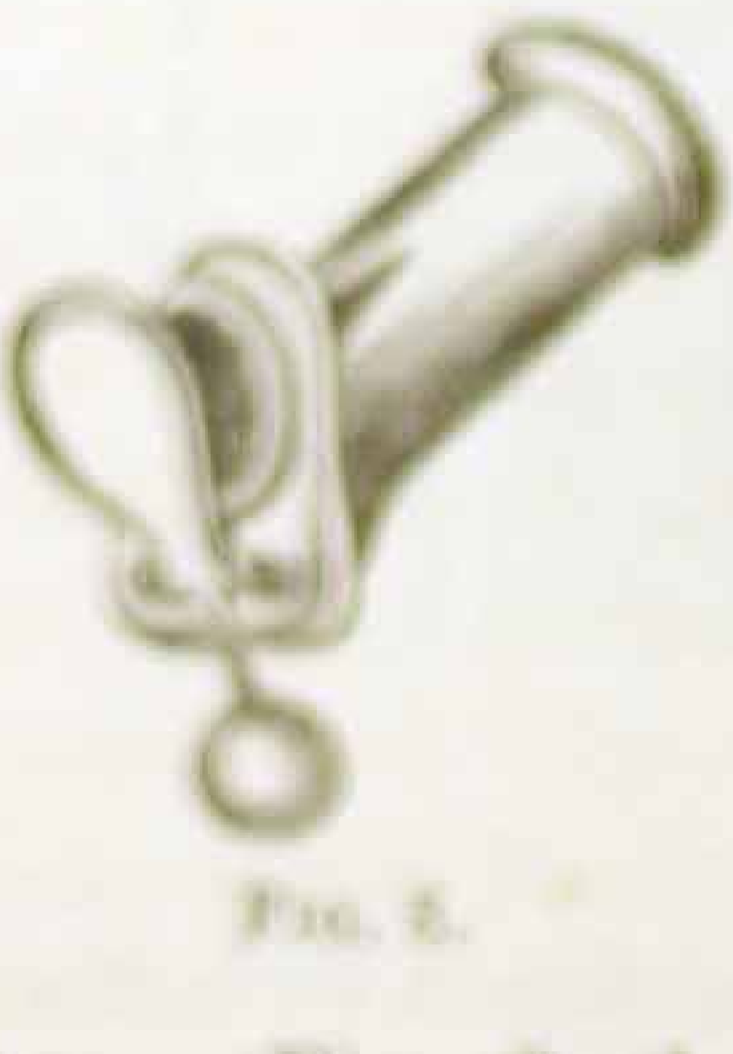


FIG. 8.

This is the whole of the contrivance by which the writer believes the smoke of the domestic hearth could be "put out" and rendered inoffensive. What the action of the water would be on the carbonic acid or carbonic oxide, the sulphuric acid gas, or any other that escapes from the fuel, he cannot say, but he presumes it could not be other than beneficial.

The present Building Act would not permit such meddling with a flue in the metropolis, but it is said a new act is preparing; if the public really care or are in earnest about the purification of their town atmosphere, the Institute of British Architects might be empowered to permit such construction as they considered safe, and which would effect the purpose. The government appears unable to undertake it. One of the blue-books issued in 1857, illustrating "the principle on which it is proposed to construct dwelling-houses," gives the representation of a flue; it is of metal 10 inches in diameter, the sole flue for eight fireplaces. The latter are placed back to back, and if the register doors were partly put together, a person in one room could see into the other, and this construction is repeated through three stories.

Kitchen flues often warm the wall to a dangerous extent. The writer, a few years back, was architect to a Restaurant Company; the kitchen he formed at the top of the house with a safe, large flue; the cook, however, would conduct his operations in the basement; the flue wall was warm even as high as the second floor, and the place was very soon nearly burnt down. Furnace flues belonging to warming apparatus in public buildings are often so hot that their course upwards can be seen by the discoloration of the wall inside the rooms. Now, such a contrivance as has been described, which the writer names "the flue pedestal," placed at any height above the fire, could be made use of either for warming purposes, or to supply hot water; the smoke, drawn up powerfully, cannot return; the inconvenience would be the immense quantity of soot left behind by the water, which must either be sent into the drains or removed.

It might be considered too great an expense to provide each flue in a building with its pedestal, but as flues are grouped together, a spray of water might be contrived for several. In large buildings where the flues are more distributed, some horizontal flues might be necessary, both to lead the smoke to the spray as well as to run off the soot. When we know that there is a power drawing the smoke towards it and preventing its return, such constructions may be carried on without fear. In the Houses of Parliament there appears to be some horizontal construction of flues in the roof, as no chimneys are seen. The smoke escapes at ornamental towers, which, notwithstanding the elegance of their design, are not agreeable objects to look at, as they are so completely coated with soot. It would be very easy to place a cistern of water in each of these towers to purify the smoke before leaving.

Water is now used for sanitary purposes to a very great extent, and we cannot use it too much; but when supplied in large quantities to the upper parts of our houses it involves the payment of a good high duty to the water companies. To meet this objection, it occurred to the writer that as our climate is more damp than cold, we might collect the rain that falls on our roofs, and perform the operation of collecting the soot in a small way at the chimney-stack. In winter, when there is most smoke, there is most water, with little or no evaporation; by putting a capping to the chimney-pots or funnels, and spreading out the lower edge, a considerable quantity of water could be collected, and the smoke projected over it would lose some portion of its soot, which could be floated away by a pipe. Fig. 9 shows an elevation and section of such a contrivance, a zinc cover carried by stout iron-work: *a*, is the water, *b*, the pipe to convey it away,—it would be self-acting, and being washed by every shower, would not be likely to get out of order; it looks rather formidable, but it is not so large as either of the zinc constructions shown in figs. 10 and 11. The rain-water might be collected in a cistern to supply one or two flue pedestals below.

The proper construction for the upper part of the domestic chimney-flue and a better plan for sweeping flues will be described in the following chapter; but, before leaving the water contrivance, it might be observed, that on the passing of the Act, several patents were taken out for the purifying the smoke of factory chimneys, by bringing it to the bottom of upright flues, and there deluging it with

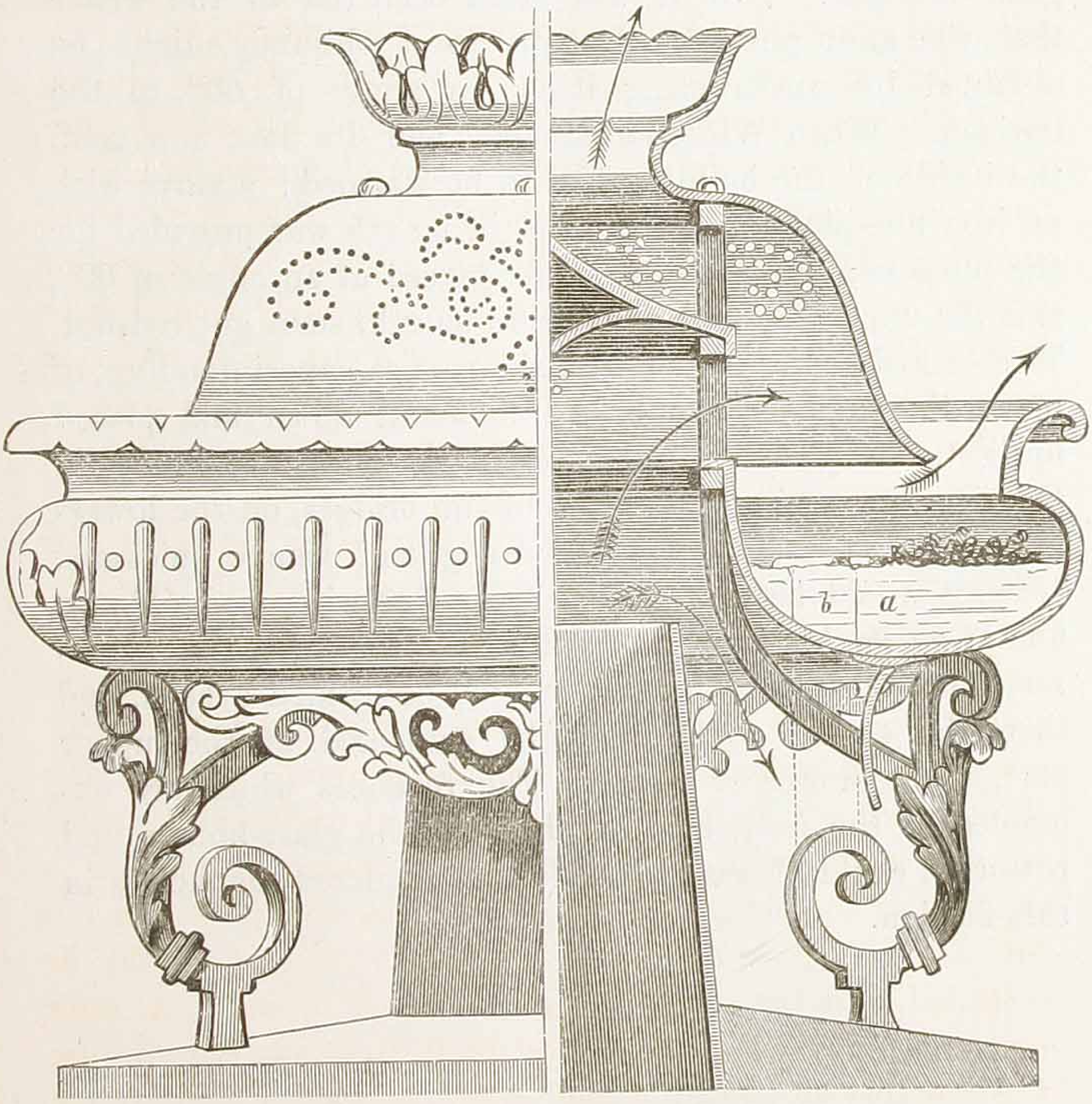


FIG. 9.

showers of water. It is difficult to understand how this could be contrived; of course, when the smoke was brought to the bottom of the upright flues, it was very easy to subject it to a deluge; but the question was, how to get it there, and this was not shown in any one of the patents. Now, next to the ugly smoke line of London, with its thousands of tall-boys and chimney cappings, the chimney-stalk of the factory is the most objectionable; where these factories are grouped together the owners seem to have an ambition as to which shall have the highest stalk, and there are some of a fearful height, which totally ruins any picturesque landscape.

Of course the intention of the high stalk is to obtain a good draught. Now it has often occurred to the writer that the most powerful draught to a chimney might be obtained by constructing it at an angle of 60° to the horizon. When Whitehall Chapel had its last new roof, the inside of the building had to be warmed; a stove with an iron flue-pipe 60 or 80 feet in length was provided for the purpose; the latter was first placed at an angle of 60°, and the upper part, for the whole length, soon got red-hot. This looked so dangerous that the parties superintending, of whom the writer was one, had it taken down and placed upright. Anyone can observe that in the penny-boats on the river, in passing under one of the bridges, on the lowering of the chimney-funnel, the draught of smoke quickens. Now, it would be very easy in large factories, to build the flue at an angle of 60° in a side wall, making it the necessary length; drying chambers might be formed over it, and then the smoke could easily be subjected, at the upper part, to a shower of water. The furnaces which are exempted by the Act, such as those of the glass-houses and potteries, could be easily treated and rendered smokeless in this fashion.

CHAPTER II.

THE CHIMNEY-STACK.

The utter want of artistic feeling in the common attempts to remedy that domestic evil, a smoky chimney, is so subversive of all good effect, so destructive to the appearance of our buildings, that the writer trusts he may be excused in suggesting a simple plan or new mode of construction, that will at least prevent as little as possible the operation called curing, and tend to abate the evil of return smoke.

Smoky chimneys are not confined to England, they abound throughout the continent, even in Rome and Florence. But the mode in which they are treated here is so truly extraordinary as to excite the amusement and surprise of the foreigner who witnesses in London those hideous abominations which form its skyline, and cause him to exclaim—

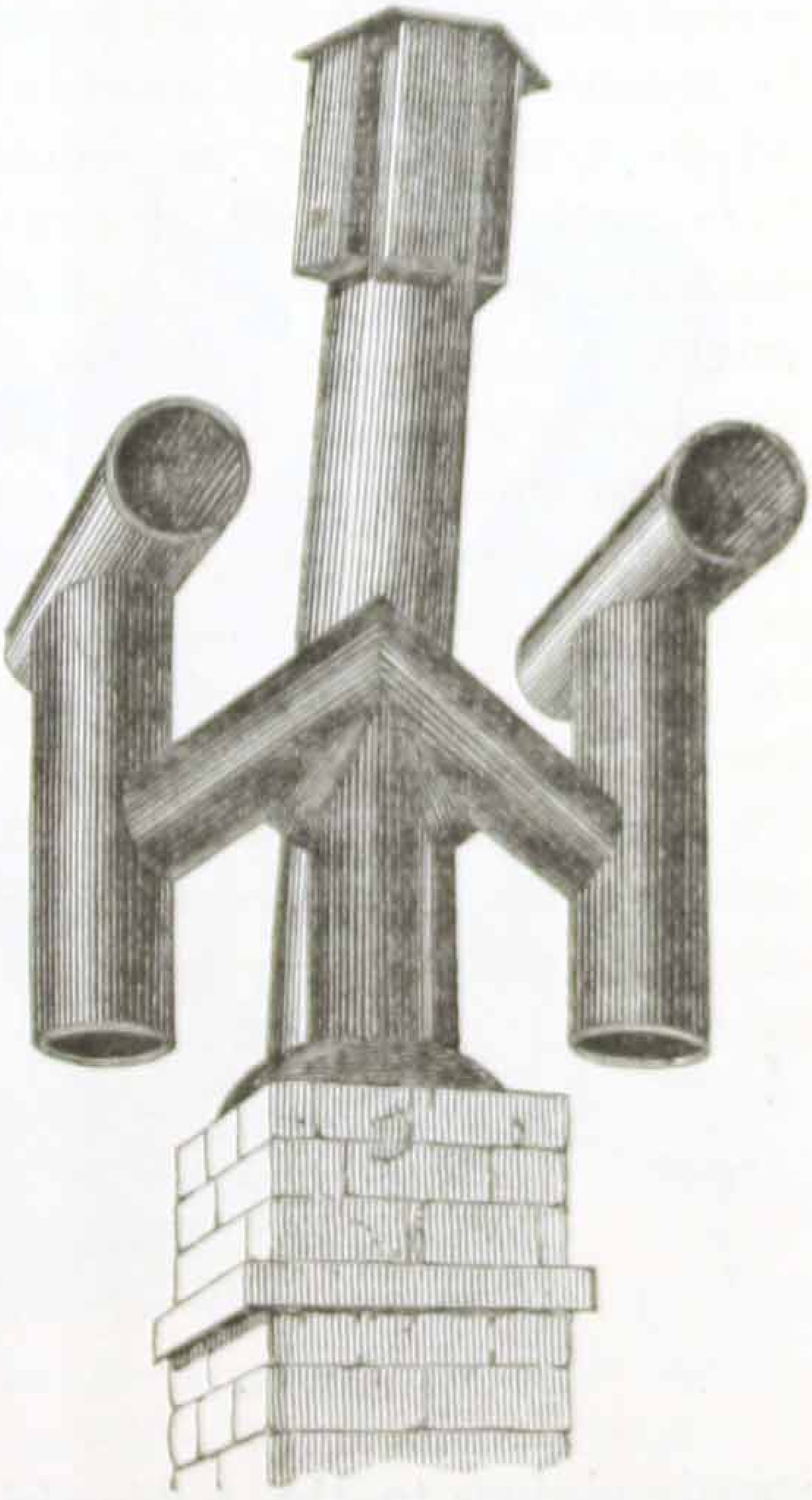


Fig. 10.

> "Non equidem invideo; miror magis!"

Rows of iron pipes called tall-boys, Hymalia funnels, Archimedian screws, lobster-and-crab-cowls, triple-crowned caps, organ pipes, tubes 10 inches in diameter arranged in line, with two or more iron rods to keep them upright, the same creeping along the roof—such are the ordinary pseudo-remedies which often have no effect, but only entail a considerable expense on the unlucky occupant of the dwelling.

In design tall-boys are bad enough, as they do not accord readily with either Greek, Roman, Italian, or Gothic elevations; but when they come to have elbows, are vandyked at the edges, have things that flap or turn round, and similar appendages, the case is hopeless.

Fig. 10 is the representation of a stack from the London Joint Stock Bank, Pall Mall; it stands about 40 feet from the ground, in a prominent position, directly opposite to the windows of Marlborough House, and it thus forms a specimen of English taste, constantly obvious to the noble visitors and occupants of that building.

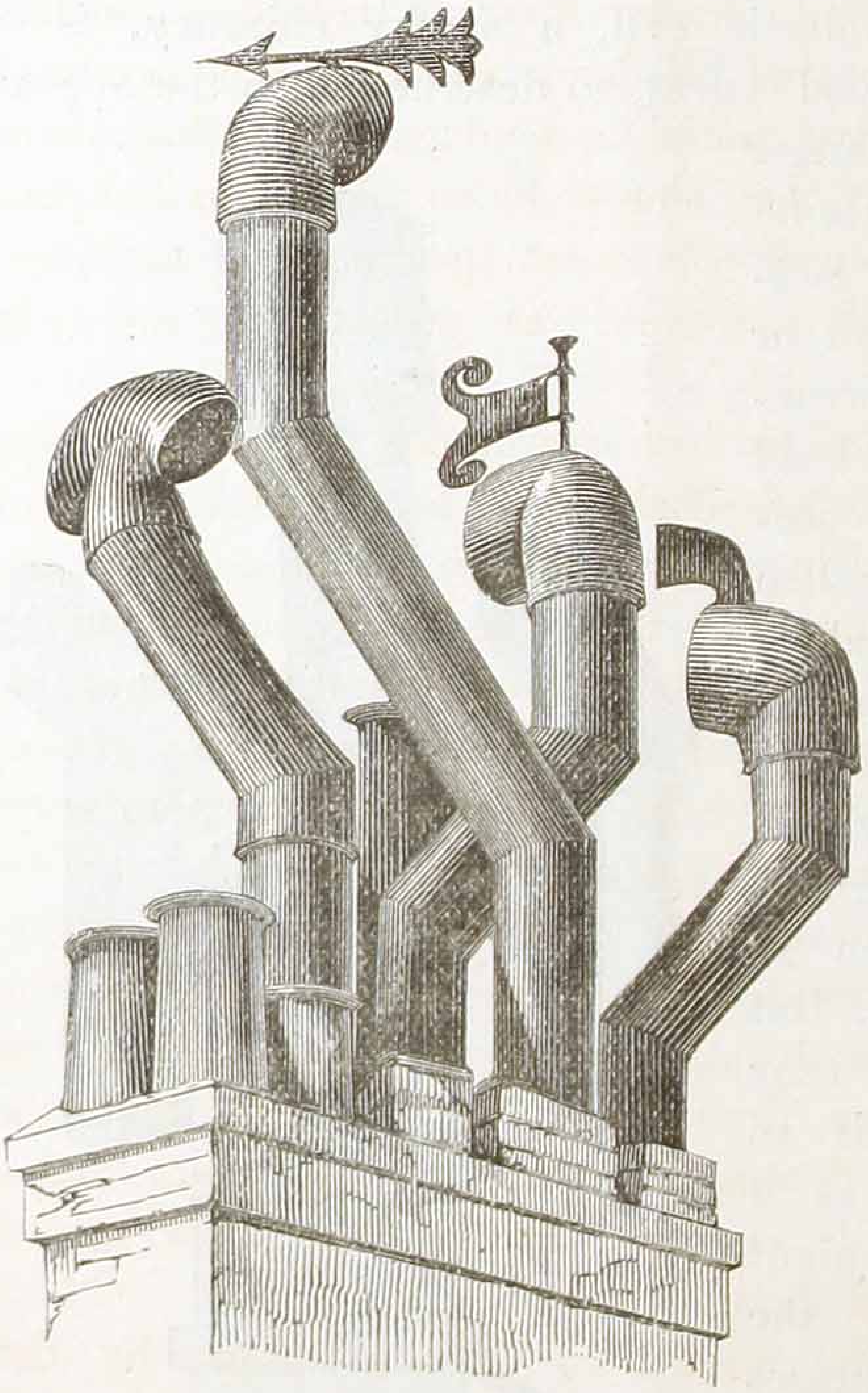


Fig. 11.

Fig. 11 is a fair example of a common London stack; it is from Messrs. Drummond's Bank at Charing Cross. The chimney-pots are nearly all gone; the tall or rather crooked boys, jut out in different directions; three have moving tops, one of which appears to have become fixed, and in that position, so far from curing the smoking propensities of the flue, it must immeasurably increase them.

When flues are carefully constructed, with the best modern improvements, and a due supply of air admitted to the stove, a smoky chimney is the exception; still the flue forms a simple open funnel for the passage of the smoke, and failures will inevitably happen sometimes; construction on a good principle should render these as trifling as possible.

Accepting as a fact that tall-boys, and the other iron and zinc constructions, are useful appendages to a flue, there can be no reason why they should be so used as to disfigure our buildings. Some of the finest specimens of architecture in the Metropolis serve only as pedestals to an ugly collection of cowls.

The writer proposes to form the upper part of the flues in a building, for a length of about 15 to 20 feet, entirely of iron or other tubing, in square, round, or oblong sections, of course of a less diameter than the brick flues to which they are attached. This tubing is gathered up in groups, and carried at an angle of 45° towards a centre stack: the tubes in direct contact with each other, having no brick wyths, except one or two to strengthen the stack.

It is obvious that if only one of the flues be in use, it would warm moderately those next to it; and if the whole of the flues of a building were to be constructed on this plan, and two or three in use, such a power would be obtained as would effectually ventilate every room, and a fire could be lighted in any one without the risk of return smoke from a cold or damp flue.

Thus the heat now wasted in the atmosphere by the action of the common flue, would be partly kept and turned to use, and the draught of the flue very much improved.

This tubing the writer calls stack flues; they could be readily introduced to either old or new mansions, as their introduction does not involve the taking down of more than twelve feet of the brickwork, measuring from the top of the coping. The tubes could never become sufficiently heated to be dangerous, and less brickwork would be required.

Clause 56 of the Building Act permits such construction, to be submitted for approval by the Metropolitan Board.

The stack flues might be made either of zinc or earthenware, cast-iron would be objectionable on account of its weight. It will be seen that they admit a better mode of sweeping than that now practised, and they could easily have some kind of capping to prevent down draughts,—as to there being any ability of entirely preventing the latter in an open flue, the writer is sceptical. The air is an element, has weight, similar to water, and acts in the same way. If the best contrived cap that could be made was placed in a tank of water, it would fill; a current of hot water will proceed upwards through a body of cold water, just as a current of hot air will through a colder atmosphere, but it requires a quiet action in both cases.

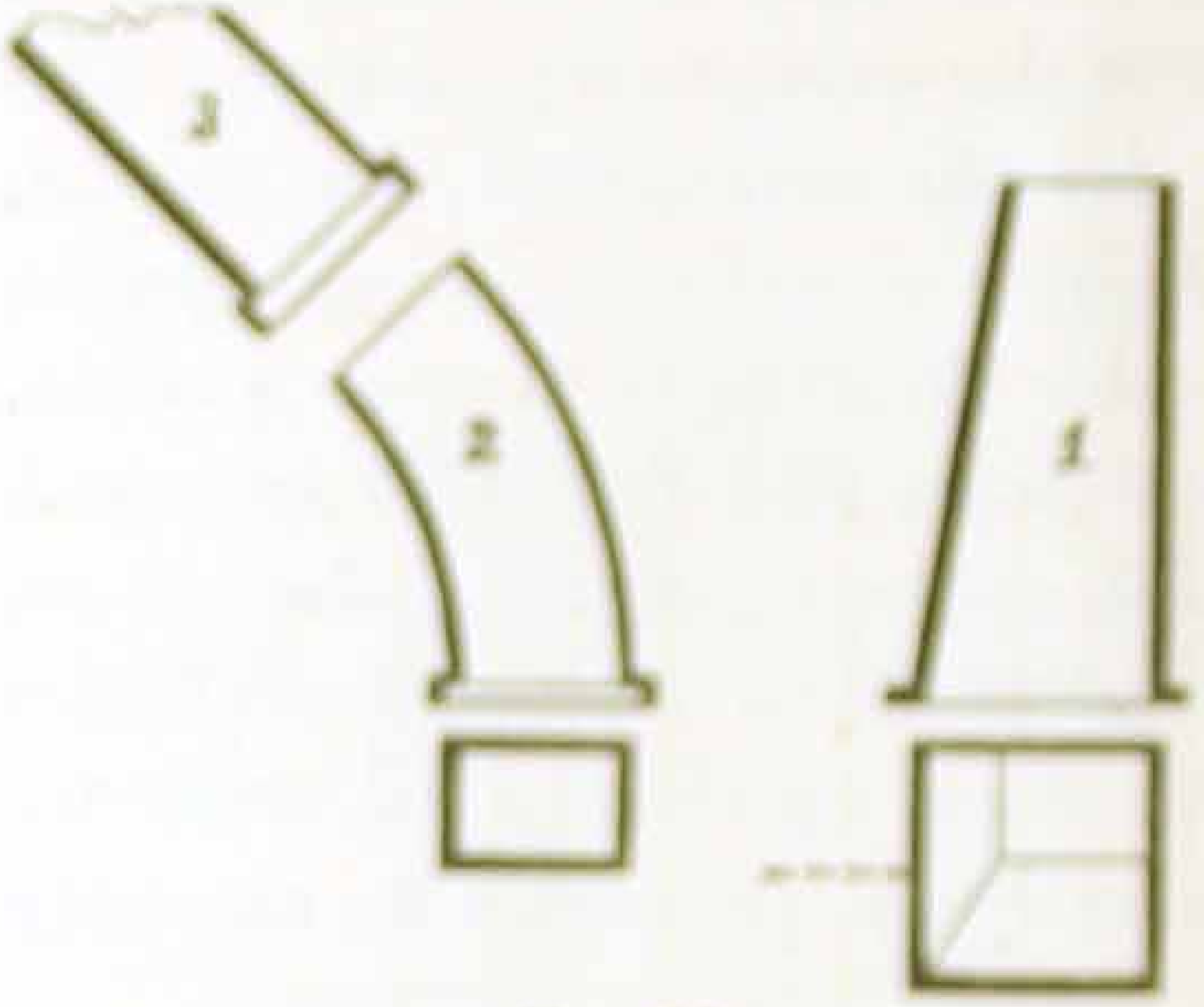
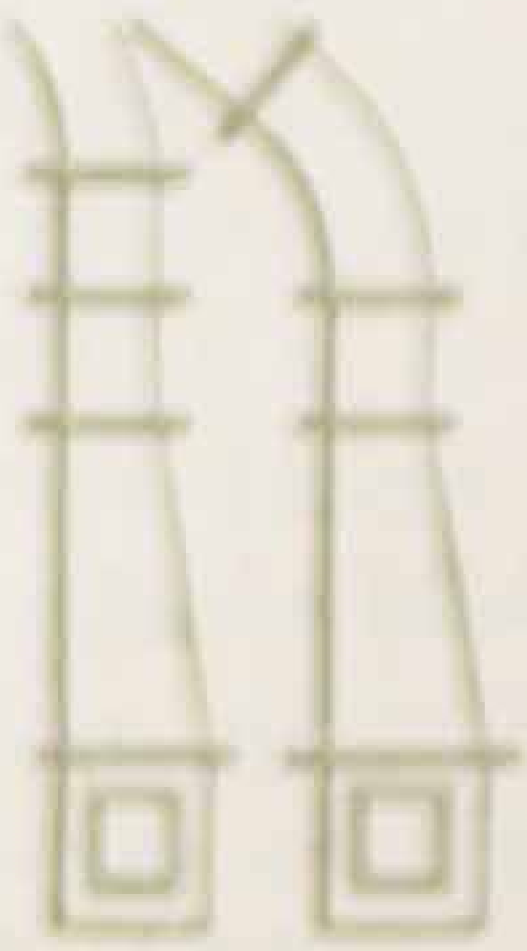


Fig. 12.



Professional men are well aware of this, and only attempt simple contrivances, that may tend to lessen as much as possible the annoyance of returning smoke; but the general public are led by quack nostrums, and a smart workman has only to contrive some odd-looking chimney-cap, and advertise no more smoky chimneys, and he soon keeps his trap and becomes a thriving tradesman.

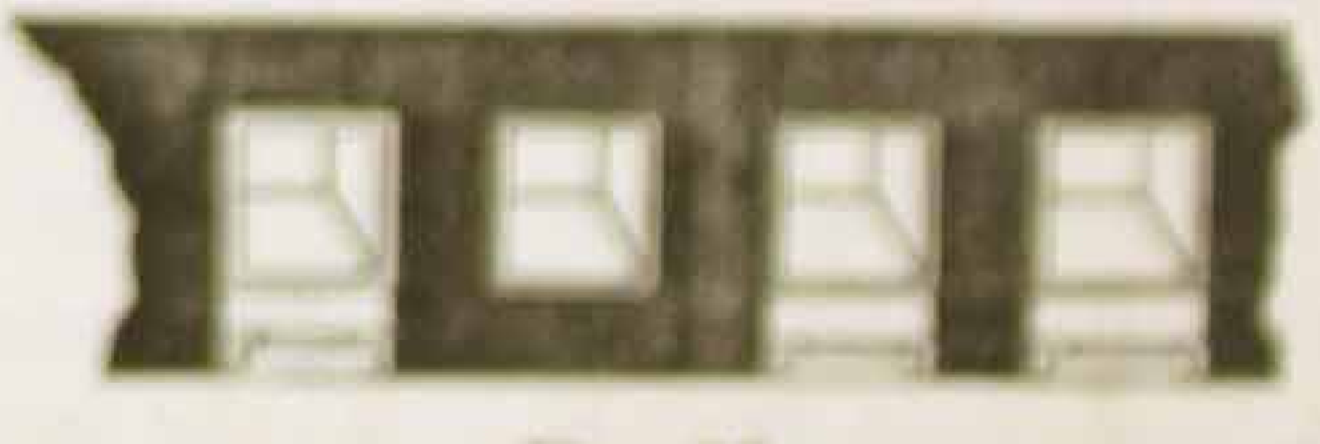


Fig. 13.

The stack flues, as is proposed, should commence or start from the attic or upper story of a building, about six feet from the floor; sweeping doors are placed beneath them, so as to give the sweep command of the flue beneath as well as above.

Each flue is composed of three separate forms of tubing, by which the various directions and turns necessary for the construction are obtained.

Fig. 12 gives the representation of the three forms. 1, is the first; this is placed directly over the brick flue, and gathers it up to a size, internal dimensions of 6 + 4½. It is 21 inches in height. 2, the second piece, is on a curve, the top and bottom lines if produced would form an angle of 45°; it is about 18 inches in height, and internal size 6 + 4½. The third, 3, is a straight piece, internal size 6 + 4½, the lengths various. Fig. 13 gives a plan of four flues, and an elevation of the commencement of two. The sweeping doors are shown below. The flue without a door is the

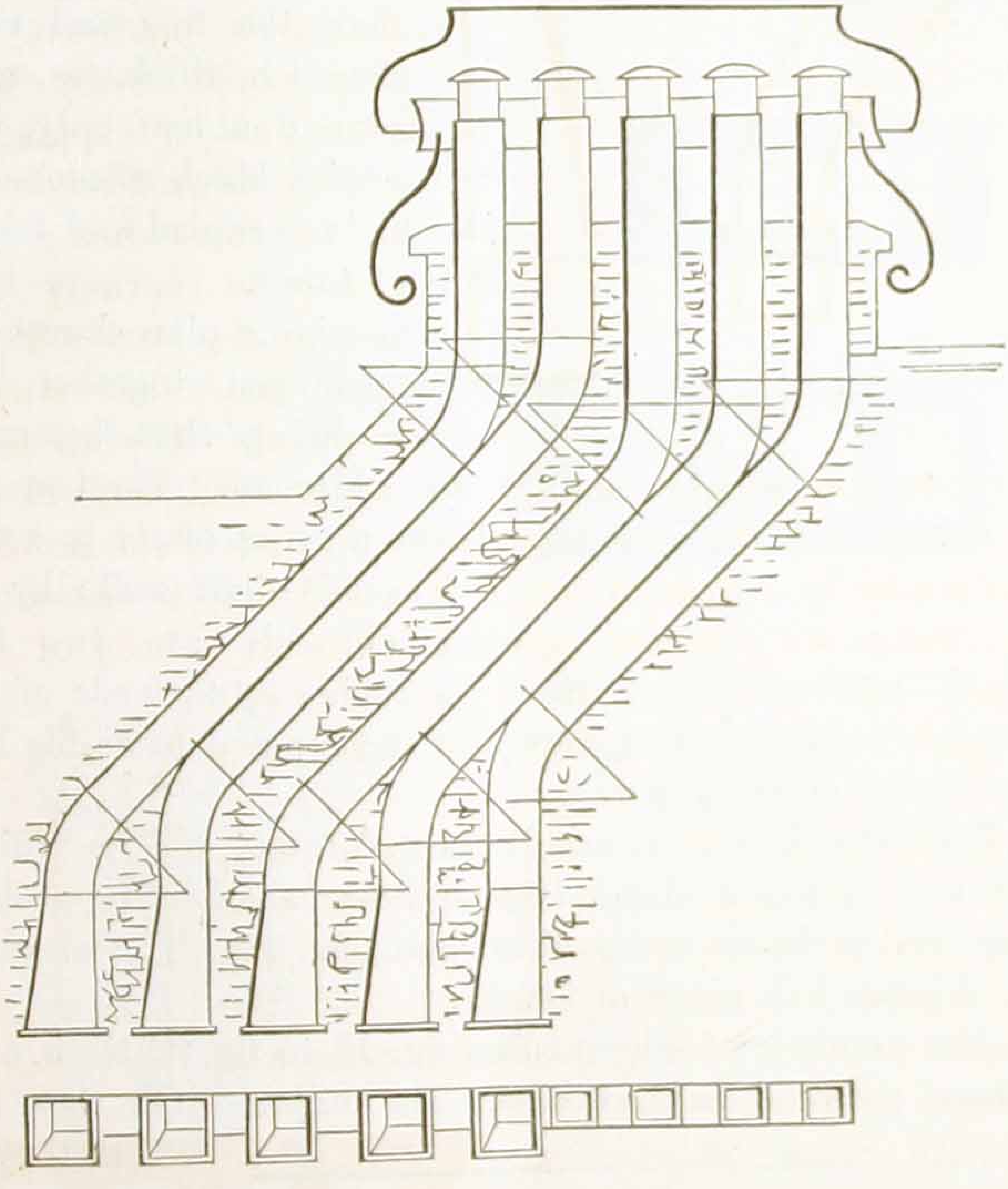


FIG. 14.

ventilating flue for the basement. The ease with which this tubing can be grouped is shown in fig. 14. The stack consists of five flues, the tube, 2, connects them together below, separates them above. This stack, above the roof, is 4 feet 9 inches in length.

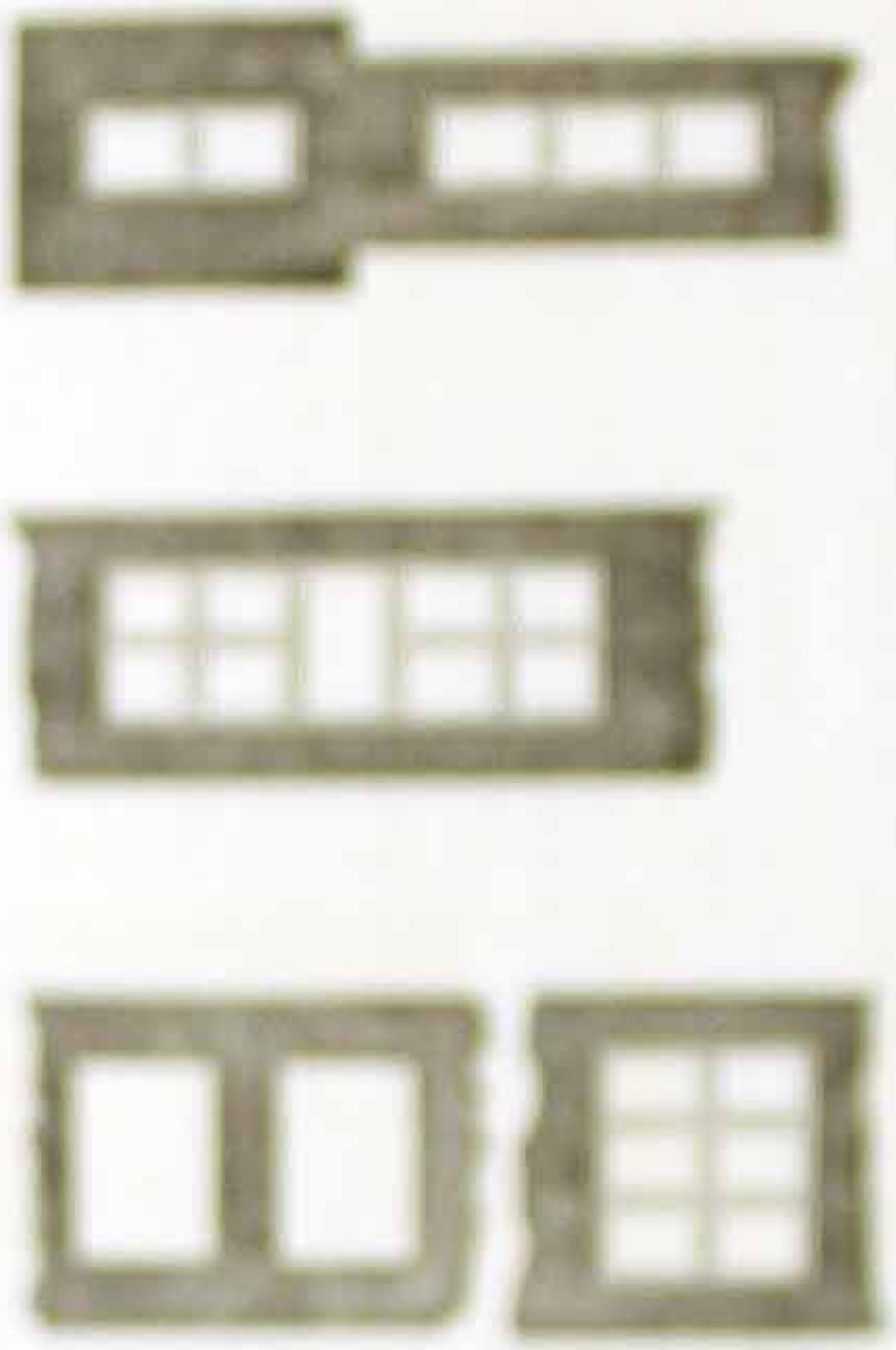


Fig. 15.

Fig. 15 shows in the upper plan how the flue wall could be reduced in thickness, made a brick and a half only, with a two-brick block at each end; it contains coupled and tripled sets of tubes.

The middle plan shows nine flues grouped together, the centre being that belonging to the kitchen. The last plan shows a group of six in a two-brick-and-a-half wall; by the side of this are two flues of the common construction 14 inches by 9, made of this size to enable a boy to get up to the top and place his head out of the chimney pot.

The tube 1, fig. 12, can be turned round and its position reversed as shown in fig. 16; six flues can then be grouped together as shown in the third plan, fig. 15. The elevation of this stack is given in fig. 17.

For a covering to these tubes fig. 18 to fig. 22 show ornamental pots and their sections. The only merit in these may be that they are of a more ornamental character than any that have ever been introduced,— they are formed of zinc, supported by a stout dwarf iron railing. The intention is to permit the smoke to escape in any direction, either upwards, sideways, or downwards, sheltering it as far as

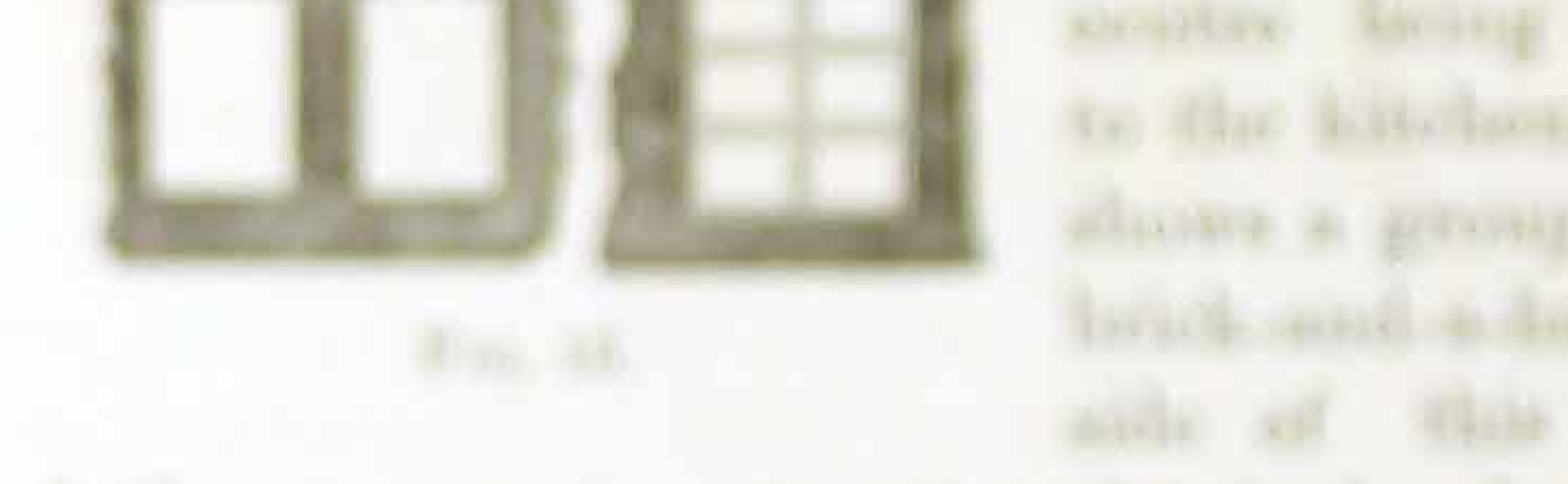


Fig. 16.

possible from any action of the wind, and rendering it of little consequence whether the stack is high, low, unsheltered or otherwise. If any sudden gust of wind takes place and the smoke be driven back, the capping provides larger outlets for its escape than the small aperture of the flue itself; in other words it is easier for the smoke to pass in any direction than to return down the flue.

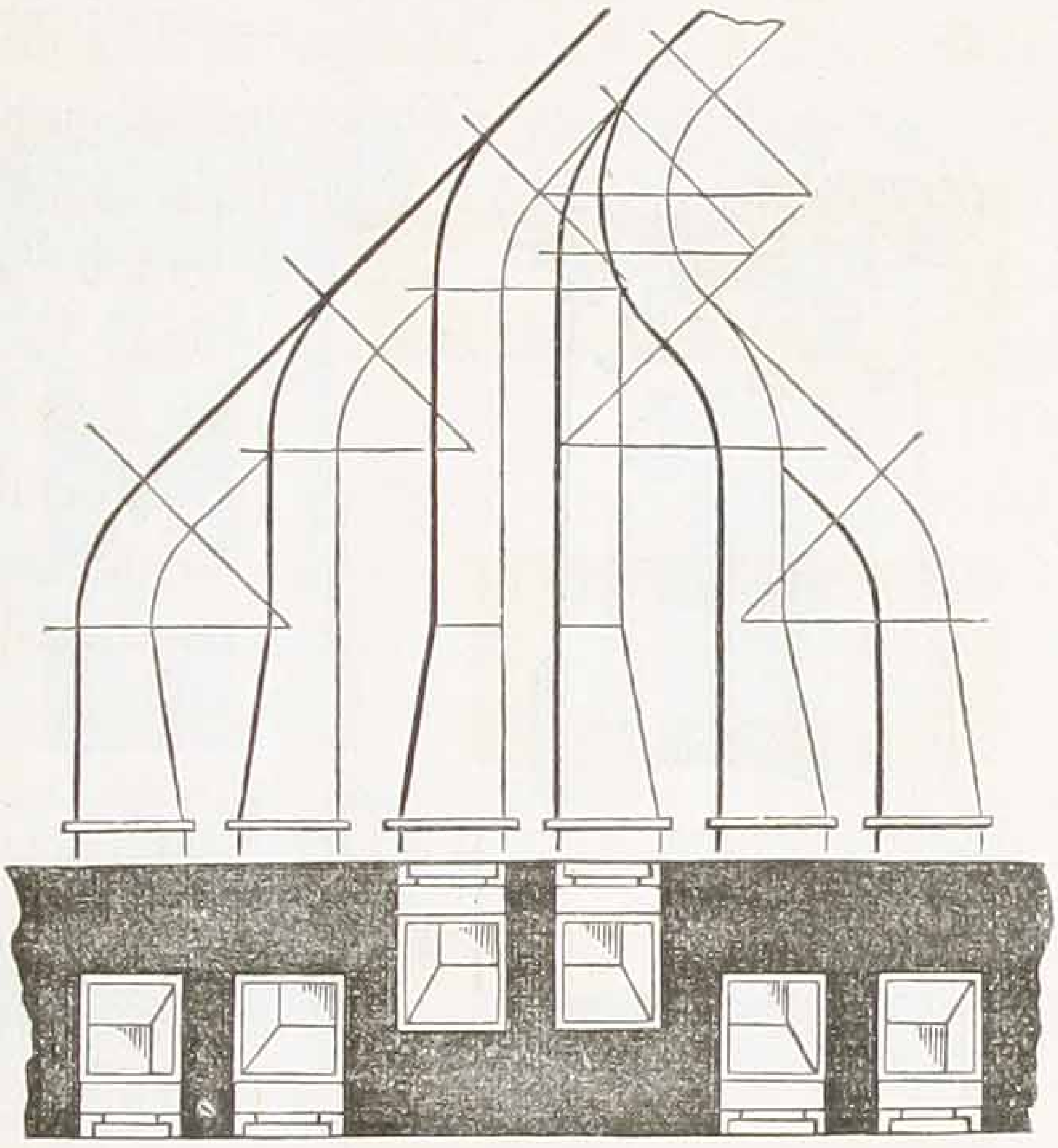


FIG. 17.

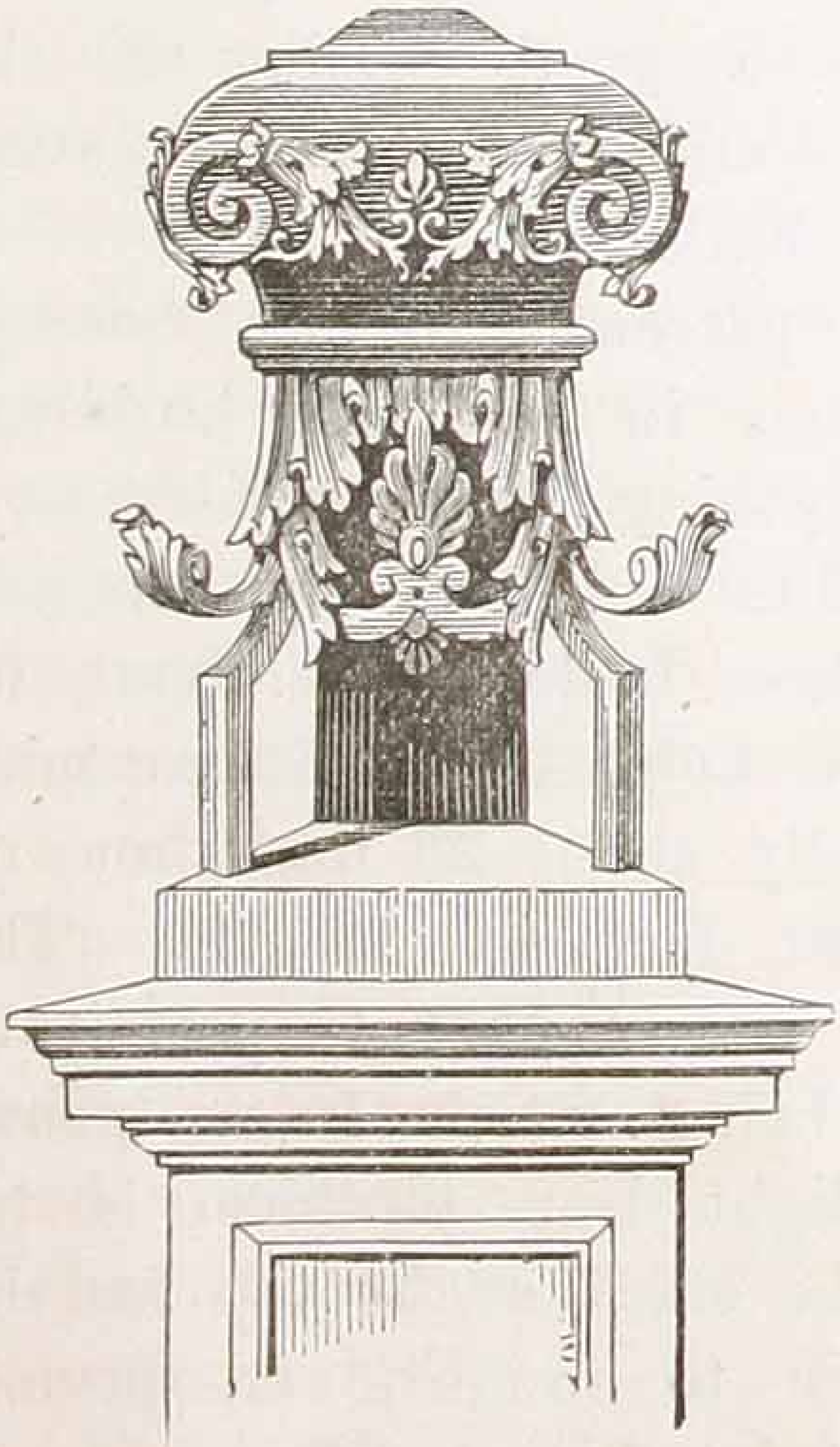


FIG. 18.

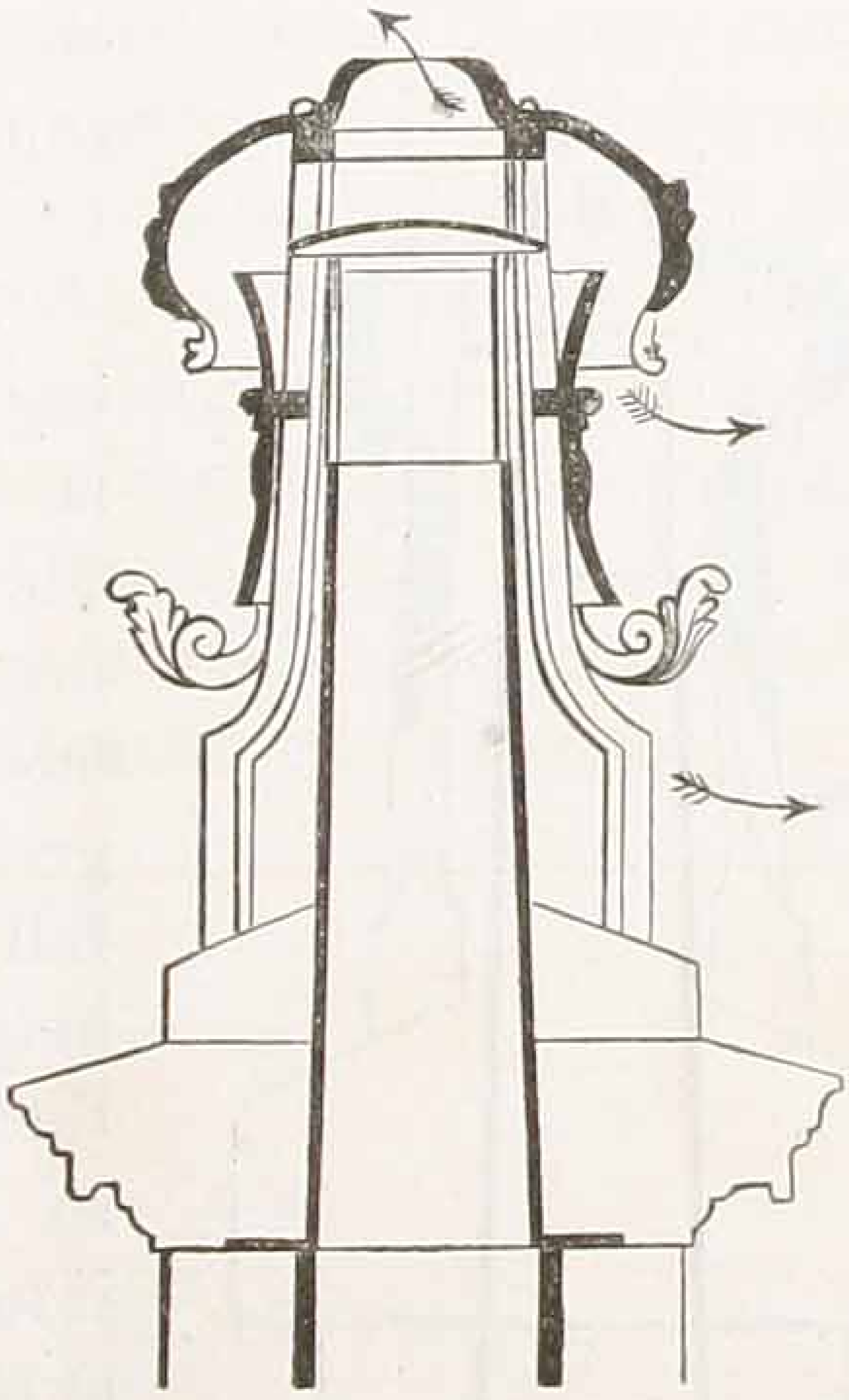


FIG. 19.

The stack tubes are only, in fact, tall-boys boxed up and not put out in the cold, and it is presumed

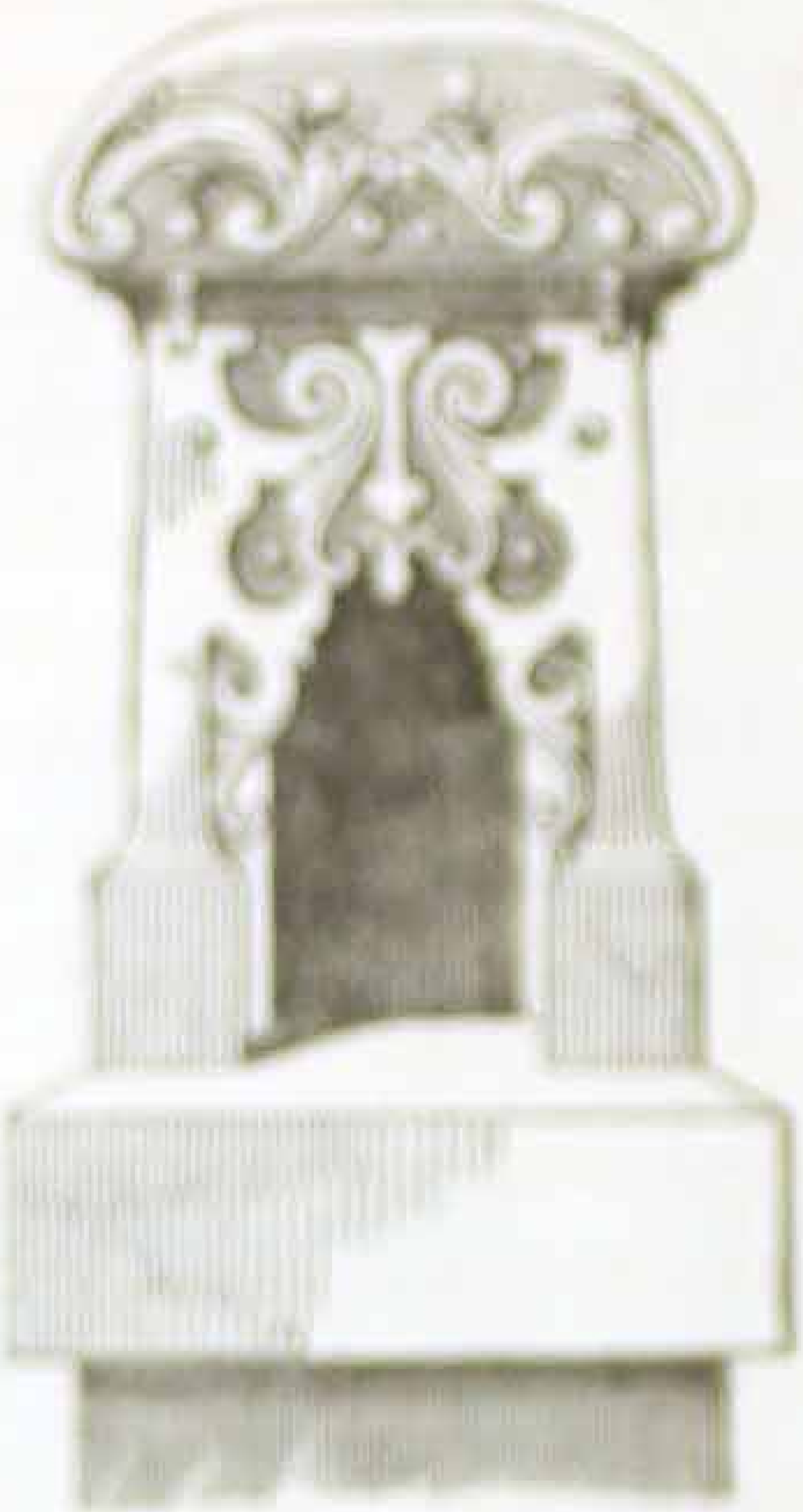


FIG. 20.

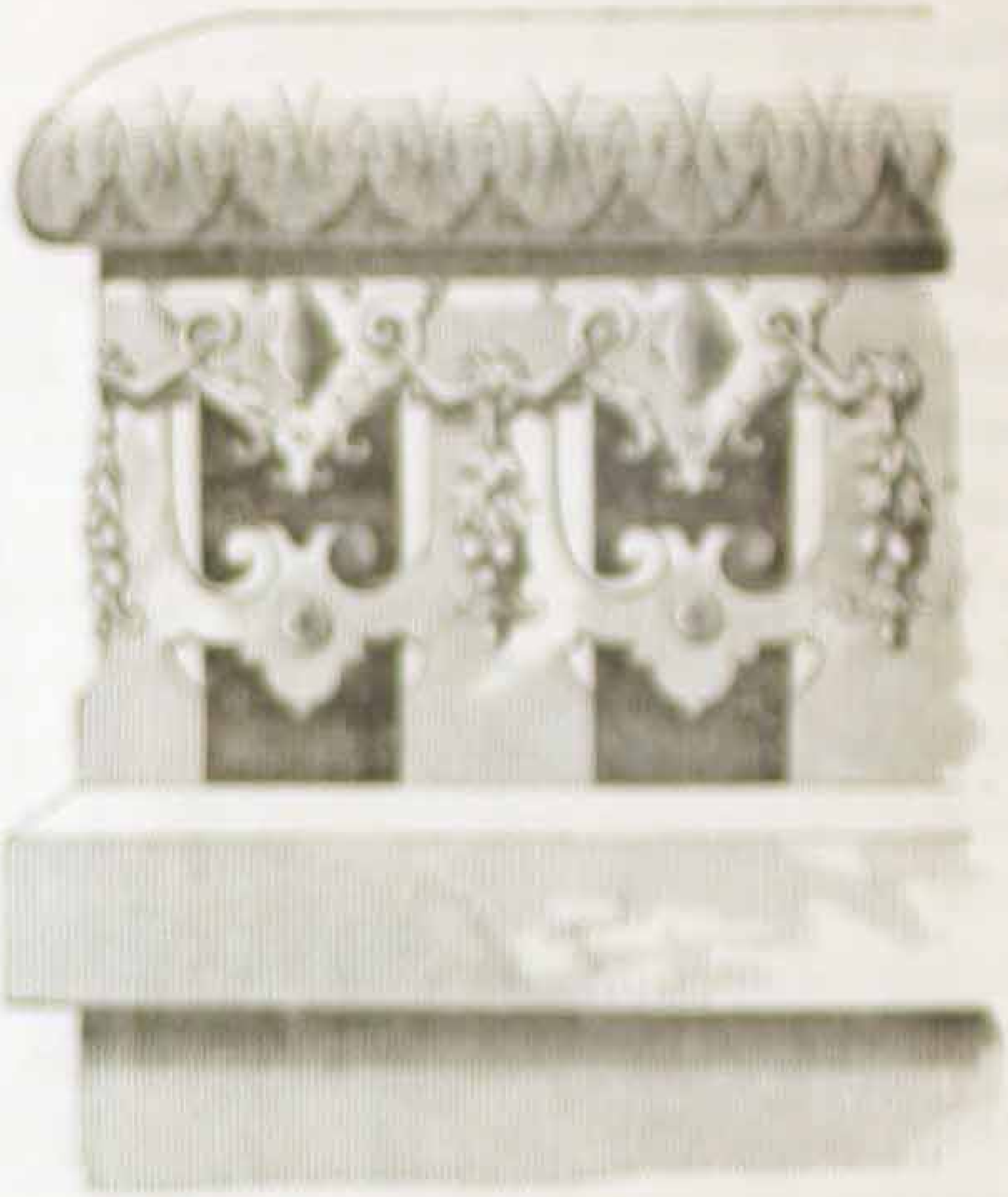


FIG. 21.

they would be sufficiently powerful from their warmth to ensure a good passing of the smoke, and to secure ventilation to the building.

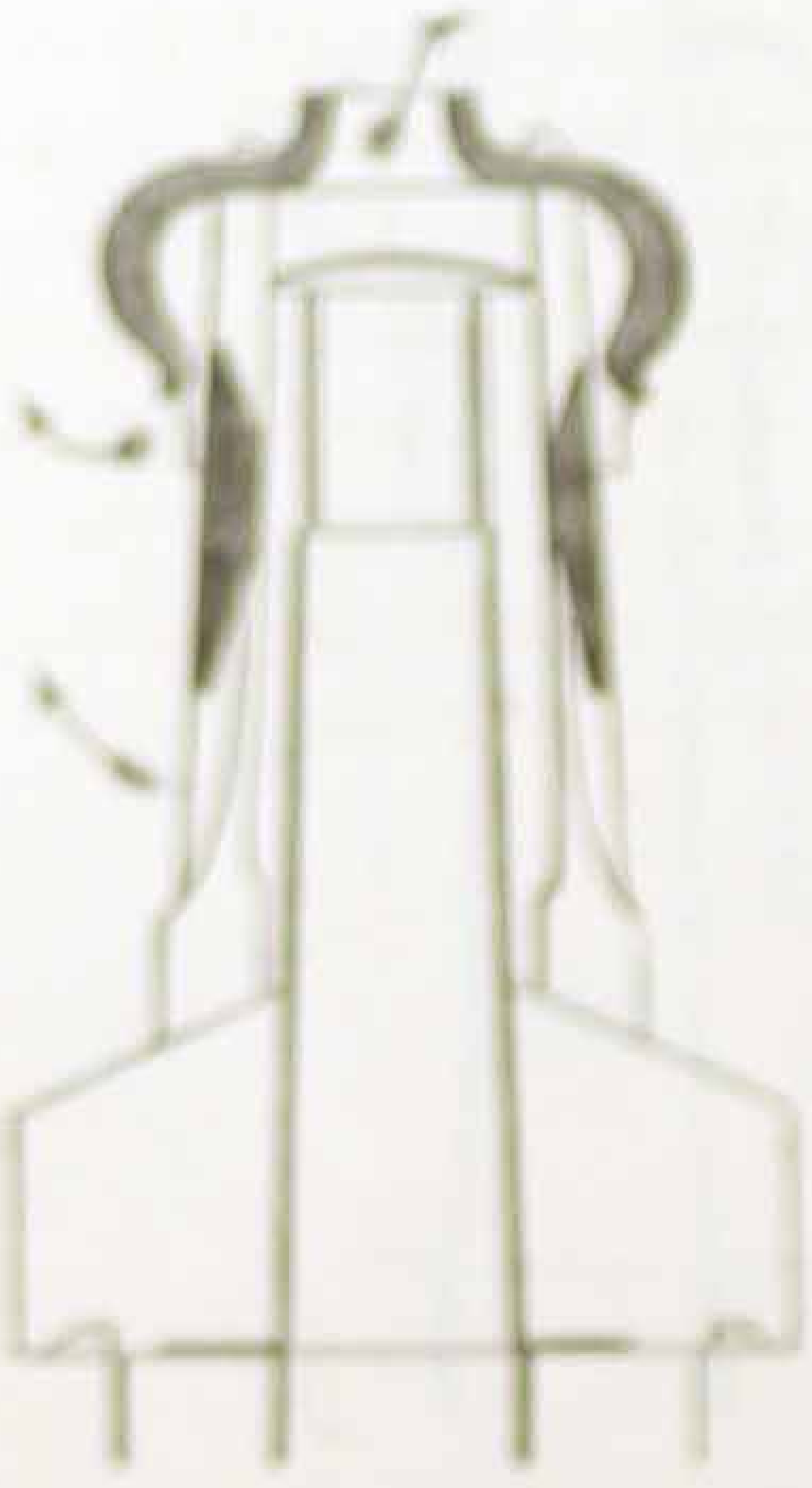


FIG. 22.

The present method of sweeping flues in our tall buildings is anything but satisfactory. The flue wall in any common first-class building is about 60 feet in height, and it contains generally about 28 flues, and is full 30 feet in length. The height is too great to permit of their being swept from below, so a light iron platform is let into the stack at the top for the sweeper to mount, and permit him to let his appliances down to his assistant. Some of these platforms have slight iron ladders attached to them, as may be seen at Ashburnham House in Dover-place. But generally in tall houses the man is left to get up how he can; he has to bring a ladder with him or get it from the house; there is the damage he may do the slating of the roof to consider. If he happens to be a big heavy man, which these men seldom are, his standing place, supported only by a wall honeycombed with flues, is not very safe; his weight might act as a lever and split the stack. That the flues are not swept in very first-rate style, it is almost, under the conditions, impossible to expect. Again, the common tall-boy tends to chill the smoke, and it collects a great deal of soot, to which there is no way of getting. Putting the sweeping doors in the upper rooms permits the lower flues to be swept properly, and to the upper a pliable wire brush such as engineers use to sweep the tubes of their boilers, would permit a perfect sweeping of the smallest, and no damage could happen to the roof. The latter seldom permits sweeping doors in the stack.

A forced ventilation of our dwellings, in ever so slight a degree, is a matter of importance. By the proper construction of these proposed stack flues, it is presumed that any amount of ventilating power, self-acting and continuous, could be obtained. Their introduction alone would be beneficial; combined with the flue pedestal, the tubes could be led into one general upward shaft; either way we should have some command over our smoke, while the roofs of our buildings might be made ornamental and picturesque. It would be a treatment of our bituminous coal alike artistic and novel, surprising to foreigners and creditable to ourselves.

CHAPTER III.

ON LIQUID FUEL.

The advantage to be obtained by using liquid fuel for steam purposes has been dwelt upon throughout Europe and America for several years past, and effort upon effort has been made to bring it into subjection for the purpose. Nature it seems does not yield her choicest gifts without demanding proportionate labour; it has in truth been said that "she is silent and full of reserve, a very Sphinx for the puzzles she sets, and the penalties she inflicts upon those who attempt to solve them." In 1864 the writer submitted to the Board of Admiralty an apparatus for the purpose of burning liquid fuel, which had been previously examined and reported favourably upon by their engineering officers.

The first operations at Woolwich Dockyard were carried on entirely at his own expense; he had his engineer and stoker with him, and supplied the oil. He was told that if he only succeeded in burning petroleum so as to demonstrate its use for steam purposes, the engineers would be satisfied, and that a great step would be gained.

On this being done, a boiler of 12 or 14 horse-power was made from his own designs, and placed at the writer's service.

The first day it was tried, May 18, 1865, an evaporation of 12½ lbs. of water power for 1 lb. of oil was obtained, and that after a trial of four hours' duration, steam having been up some time. It was carefully attended and directed by the chief engineer of the yard in person. Only 6·47 lbs. of oil was burnt off per hour, per square foot of fire; this was considered a slow combustion. The smoke was light brown, and moderate in quantity. The work of the coal testing furnace of the yard was compared against it; that could burn off 25 lbs. of coal on the same space in the same time, each pound producing an evaporation of 8 lbs. of water.

It was not till May, 1866, after constant attention, that the writer succeeded in obtaining a combustion of 13·76 lbs. of oil per square foot of fire per hour, each lb. vaporizing 15·14 lbs. of water; this was therefore 208·32 for the oil against 200 for the coal, but the oil boiler had the larger proportion of heating surface, and the combustion was attended with a great deal of smoke and soot. For these oils when burnt alone in a close furnace make sufficient of both to shame coal.

The writer was on the point of abandoning his efforts when he determined to try the American plan named in several of their patents for decomposing water vapour into its constituent gases, oxygen and hydrogen, mixing them with the petroleum vapour and burning them together. Their want of success, for they had not obtained any real practical result, struck him as not owing to any inherent defect in the oil, but simply from having failed to discover the proper means of applying this peculiar description of fuel, or rather of the two fuels—for the use of water as an auxiliary fuel was even less understood than that of the petroleum.

The American plan was to vaporize the petroleum, superheat that and steam in coils of pipe, mix the two vapours with air in a retort, and burn the mixture from batswing burners. Three lines of pipes were placed over each other, a wood fire being first made beneath to start them. It was evident defects existed in this plan; it appeared to the writer that by introducing steam in a more simple manner in the grate, it would be managed better and become more effective.

His own chemist, Mr. Frank Wright of Kensington, told him that beyond an improved mechanical effect, he did not believe more heat could be obtained, but he would not advise the trial to be abandoned, as facts had so often falsified theory:—the latter as to water fuel was that no advantage could be gained by using it as an auxiliary to any other fuel, because it took as much heat to decompose water as it gave out during the combination of the gases which constituted it. This, the natural law, has been often pronounced incomprehensible, and to be useless to man. The writer is no chemist, which confession may perhaps not be needed here; what he has gained in chemical knowledge has been by a close observation of the action of these oils in the furnace. He considered, then, that exhaust steam might be made at least to give back to the furnace the heat it had previously taken from it; and being permitted by the Admiralty to make the experiment at his own expense, he determined that if it could be done it should be done, and he did not believe in any natural law that could be useless to man. He applied the steam to his grate his own way, at first rather too vigorously, but success attended the operation; the first few minutes proved that water could be burnt and a smokeless fire produced. Before the hand was off the tap that turned on the steam, the whole mass of blacks on the surface of the grate rose and disappeared, not up the chimney funnel, but in the flame. This flashed to four times its usual size, was perfectly smokeless, and so bright that it pained the eye to look upon. Its temperature became higher, and the evaporating power of the boiler was so largely increased that the small force-pump which had been given to supply the feed water became too weak, and had to be changed for the largest in the yard.

It required two months' attention to find the best method, without disturbance to the furnace, of introducing the steam; very little of it was required, and none of it was wasted. If run in in excess, it put the fires out and came up through the grate undecomposed and unburnt.

It was evident that the true method with these liquid fuels was to use them with water as an auxiliary fuel. If the latter gave no heat itself, which is a matter of much doubt, it prevented smoke by using up the spare carbon of the oil, completely burning that, and obtaining its full value.

Only about five per cent. of the whole amount of steam made by the boiler was used, and the evaporation advanced to upwards of 18 lbs. of water per lb. of oil; the small boiler was kept at work day after day producing this result, without smoke, and without, the writer regrets to add, attracting much attention. Mr. McLagan, M.P., came down to see it, and was so struck by its performance that he told the inventor that it ought to be more fully known; and on his motion in the House of Commons, a report was issued of the trials.

During all this time the boiler only gave a low rate of combustion; it could not burn the oil in sufficiently large quantities to equal the rapid firing of a coal boiler.

The government report gave the following result of the boiler in comparison with the coal testing boiler in the yard.

	Woolwich coal test boiler.	Richardson's oil boiler.
Water evaporated per 1 lb. of fuel .	8	18·38
Fuel consumed per sq. ft. of fire-grate per hour	25	8·44
Water evaporated per sq. ft. of fire-grate per hour	200	154·17

In February, 1867, the boiler produced an evaporation of 18·91 with creosote. Mr. Crow of West Ham superintending.

The slow combustion was, although not seen at the time, a fault on the right side, being one that permitted improvement. The surface of the writer's grate was flat, and allowed only a thin stratum of oil on its surface; coal could be piled up 10 or 12 inches in height on the fire bars, hence its advantage. On the 18th of May, 1865, the chief engineer reported that the oil grate required to be "2·45 times that of an ordinary coal grate, to burn off equal quantities of water in the same time;" the proportion of oil to coal then was "81·7 to 201·00." In August, 1866, it was 154·17 to 200.

Mr. Lloyd, the chief engineer at Whitehall, who wrote the House of Commons report, gives the average rate of evaporation for the three last experiments, per square foot of firegrate per hour, as 147 lbs. of water; or a little more than two-thirds the rate of evaporation in the coal trial boiler.

A simple remedy for this existed, which was not then seen by either of the engineers or myself.

No invention is perfected at once, or is likely to be successful from its birth. At first practical difficulties arise, unexpected mistakes are made, and a few experiments are unsuccessful. Considering the slow combustion was due to the small boiler, and the report by the government, prepared by the chief engineer at Whitehall, recommending that for future trials a large boiler should be used, application was made for one, and the *Teazer* gunboat boiler was placed at the writer's disposal, and at considerable expense to the government, fitted up for him, from his designs. He had been told that he could do more with superheated steam, and superheaters and retorts, each pair weighing 12 cwt. 2 qrs., were provided and placed within the two fireplaces. He had only to supply the oil. The boiler was first tried with coal—the result was given in our first chapter. The first day an evaporation at the rate of 7·53 lbs. of water per lb. of coal, slow firing with little smoke; and the second day one of 6·608 lbs. of water per lb. of coal, rapid firing with dense smoke.

The slow combustion of the oil was found to be the same in the great boiler as it had been in the smaller one. It was only able to produce an evaporation of 32,096 lbs. of water per 2607 lbs. of oil in each of the two days it worked. In July, 1867, it could not reach the second day's coal evaporation of 39·648.

Coal was again successful. One set of superheaters and retorts were destroyed after ten hours' working each day; the second set was preserved only through some fault in the mechanical construction of the fireplace, which did not act through a portion of the second day.

The steam, of which a large quantity was used, had very little effect; a small portion only of the fire was clear and bright, the rest sent out a large amount of smoke. The writer had departed from his system, and was thrown back, but for a time only. The trial was a step to success; it showed him what was false in the process of the water combustion, and it exhausted and threw over a tempting form of error. The expense of the reconstruction of the furnaces, however, rested with him, and as this was a large matter, he hesitated, having already expended a considerable sum. He was requested to take the remainder of his oil from the yard, 20 full barrels and 30 empties, which became a loss.

The mode by which a fuller combustion of the oil could have been secured, is now fully known, and it appears extremely odd it was not seen or found out before. It was simply having upright surfaces instead of a dead flat one. A grate of the external dimensions of 6 feet by 3 feet, or 18 feet superficial, could by this device have as easily 60 feet of fire surface as 30. The evaporating power of the oil would diminish probably, similar to coal, the quicker the consumption. The writer had all the time a small grate at his engineers', made in 1865, which solved the difficulty; it had been made for a retort to burn heavy grease. It was not tried at Woolwich, as it was considered unsuitable to a marine boiler, having an open outer case partly filled with water. The grate was sent lately, at the request of one of our principal shipbuilders, to his engineer at Birmingham for examination and report.

It was found at Birmingham that the new form of grate easily burnt off 18 lbs. of oil (creosote) per square foot of fire grate per hour, measuring the outside rim. No account was taken of the evaporation, as this was known, the object being to see how much oil the grate would burn off. Taking the evaporation at 16 lb. the result, as compared with the testing coal boiler at Woolwich, would be—

	Oil boiler.	Coal boiler.
Pounds of water evaporated per 1 lb. of fuel	16	8·
Pounds of fuel burnt per sq. ft. of grate per hour	18·	25
Water evaporated per sq. ft. of grate per hour	288	200

So that 12½ lbs. of oil would produce the same amount of evaporation as 25 lbs. of the best steam-coal, when very carefully burnt.

The writer had been informed from the Comptroller's Office that if he forwarded the result of any of his further experiments with liquid fuel, their Lordships would cause the same to be examined. He therefore enclosed the Birmingham engineer's report, accompanied with full illustrative drawings, and requesting permission to finish the experiments at Woolwich. This request, however, was not granted; the drawings and report were returned with thanks, and the writer was informed they had been noted in the office.

"They manage these things better in France."

The problem how to obtain rapid combustion of the oil on a brick-floor had been a difficulty there, and has only lately been solved. M. Henri Sainte-Claire Deville, who has a furnace for burning liquid fuel something similar to the writer's, but without steam, has just given a description of it to the Academy of Sciences. He stated that one of his difficulties was to burn off the large quantity of oil required to work a 300 horse-power engine; he succeeded by artificially increasing the fire surface without enlarging the dimensions of the fireplace.

M. Deville is working under the patronage of the Emperor, who bears all the expense. The apparatus was first placed on board the little steamer *Puebla,* belonging to the Emperor, and afterwards in a small locomotive which drew the Imperial train from the town of Chalons to the camp.

The Emperor, in the full uniform of a general, mounted the tender, took his place on the metal platform by the side of the engineer, and during the journey watched with profound attention the operation of the furnace, until the train reached its destination, where considerable surprise was expressed by the assembly which waited in the station, to see His Majesty occupying a place next the driver, instead of in the Imperial saloon.

M. Deville arranged his grate so as to present the largest possible surface to the action of the fire. The consumption of oil (*Engineer*, March 5, 1869), at the rate of 60 kilometres per hour, was at the rate of 4·00 kilogrammes per kilometre.

The question of oil against coal resolves itself purely into a question of price. When it is fully understood that the cost of the oil will not be enhanced by its employment to create steam (and that will not be when an extensive demand is made for it), and that great gain will be secured by its use, all difficulties to its introduction will vanish. At present the supposition is that it is much more expensive. In a letter from Scotland which appeared lately in *Engineering*, it was stated that a steam-vessel had already made a trip from a Scotch to a foreign port, under oil as fuel; that it worked perfectly satisfactorily, but had been discontinued on account of the expense. Assuming that the oil will always be more expensive than coal weight for weight, unless it is worked so as to produce an evaporation from two-and-a-half to full three times that of the best steam-coal, it will not be economical. The only way to master the oil and obtain this, is by the use of water as its auxiliary fuel; that at least can make it give its full theoretic value, from 20 to 21 lbs. of water evaporation per 1 lb. of oil. The "incomprehensible law" gives us the power of obtaining a complete combustion of a superior fuel, with the annihilation of smoke and with saving of labour to man.

The working of it, now that it is found out, appears a very simple process. The two gases, oxygen and hydrogen, must be caught and burnt in the exact proportion they require to be in to form water; the least mistake or improper treatment loses the oxygen, which escapes or is rendered of no effect. The hydrogen alone does not effect much beyond preventing smoke. An evaporation of from 16 to 20 lbs. of water from 112° F. per one pound of oil, without producing a high temperature in the furnace-room, can now be obtained for any length of time without ceasing—the fire as easily managed as the light of a gaselier.

The best steam-coal in real practice produces an evaporation only of from 6 to 7 lbs. of water from 112° F. per one pound of coal; with a high temperature in the furnace-room, that at 140° always tells its tale in the consumption of fuel, careful stoking does not take place, and it is not in human nature that it should.

The oil in stowage requires 60 per cent. only of the space allowed for coal, so the great gain and the greater economy by the use of the oil, when it is treated properly, becomes apparent.

The cheapest and strongest oil-fuel is the refuse of the shale-oil distillers. Every ton of shale crude-oil on refining leaves a large percentage of this; let a market be found for it, the manufacture of the clear-burning oil would become one of the largest and most important pursuits of Great Britain. The natural oils can be used for fuels, but the explosive spirit should be first extracted from them; this can be done by a blast of steam being sent through them.

The amount of shale in England and Scotland is so vast, it is said to be inexhaustible. Some of the richest specimens of the different varieties of albertite, cannelite, &c., produce 115 to 150 gallons of crude-oil to the ton, but the average amount yielded by the common shale is from 30 to 40 gallons. Immense fields, or rather regions, exist of it both in Canada and Australia—plenty of labour and plenty of cheap material for the future generations of men.

Creosote, which can be obtained at present at a very low price, makes as strong fuel as the best oil; so does naphthaline, still cheaper than creosote. But the latter would not give 1 per cent. of the amount required for sea service, and the naphthaline only a small fraction.

Creosote has already secured its footing in our Dockyards. Jets of high-pressure vapour are used in the plate-heating furnaces, and perform the work in one-fourth the time required by coal, and do it better, heating the plate more equally. The jets are sent in against the draught of the chimney, consequently the products of combustion, if there are any, have to proceed back through the flame to escape at the flue, which in these furnaces is downward. This mode of treatment is well worth attention.

Creosote is likewise used as fuel by several of the chief tar-distillers, saving them one half the sum they formerly paid for coal. The writer has not seen the process in operation, which is one by injection. It was described by the *Engineer* (March 1, 1867) as being very noisy. It said, "If the sound must necessarily increase in proportion to the quantity of fuel consumed, the thunder of artillery in a naval engagement would be completely drowned by the 'trumpeting' of boilers generating thousands of horse-power." The injecters act somewhat the same as Perkins's steam-gun, exhibited at the Adelaide Gallery about 35 years back.

Both these Creosote systems for steam purposes effect about half as much again as can be done by the best coal.

Our large ships and their powerful engines now require a stronger fuel than coal. One of our first engine-makers has developed 8525 indicated horse-power—a power never exerted by any one pair of engines, ashore or afloat. It is very unlikely that any exertion in the stoke-hole with coal as fuel could suffice to generate, for six hours at a stretch, steam enough to work such engines. It would be certain that the resistance they would have to encounter in the open Channel would stop the progress of the vessel, if she had to depend upon steam power alone.

As such engines increase in size and power, they appear to encroach on the space allowed for coal bunkers. The *Warrior*, built a few years since, we are told by the *Times*, could only carry coals for a few days' consumption; the same authority says the *Hercules* and the *Bellerophon* can carry still less.

The rig of such vessels therefore cannot form a subordinate part to the steaming power, which it is evident they should do.

India is said to abound in petroleum; this was noticed in the *Calcutta Engineer* as far back as Feb., 1866. It stated that it was likely in a few years to supersede, as furnace fuel, the very indifferent coal found there.

The use of its natural fuel would be of vast importance there, rendering her independent of England, to meet the increasing demands of her steamers, her railways and manufacturing industry. It would cover her rivers with an active steam flotilla—give us the power of passing on the rivers of Central Asia.

The Amu Darya, the Oxus of the ancients, is navigable up to the frontiers of Afghanistan, and it forms the principal artery for commercial purposes of the whole of Turkistan and of nearly all the most important states of that region. It is navigable for nearly 2000 miles.

That there is oil in Burmah is well known. A gentleman who has just returned from Scinde told the writer that it abounded there as well, and he was very anxious for every information as to how it could be used for fuel, and said unless it was so used, both marine and locomotive progression must remain stationary. Another gentleman, Mr. Goodenough, told him likewise that he had a concession grant of a portion of the oil lands at Assam, and was anxious to utilize the oil; he said that one of his borings alone produced 450 gallons per day, spontaneously, without pumping. His wells were in the jungle, 800 miles up the Brahmaputra, and 4 miles from the river; at present there were no roads, and no means of getting at it in large quantities to bring it away. It was, on the spot, at the nominal price of 5*s.* per ton; coal was sent up the river at from 3*l.* to 4*l.* per ton.

In 1866 the writer received a communication from the agent at Muree of the Delhi and Punjaub railway, requesting information as to how petroleum could be used as fuel. He said it existed there, and that every other fuel was getting daily more and more scarce. In reply, he sent drawings showing the construction necessary for its use to a locomotive, with full instructions for its use, and especially for its careful handling. He heard no further on the subject; he has since submitted them to the Indian Flotilla and Punjaub Railway Company, and offering that if oil fuel was really of importance in India, he was ready to direct the construction of an oil grate at their engineers' works, and instruct any person they might appoint in the use of the fuel. He informed them that a marine boiler could be easily fitted for it, and at little expense, but that the fireplace of the locomotive required the substitution of water space instead of fire-bars. He has been politely informed the subject will be taken into consideration.

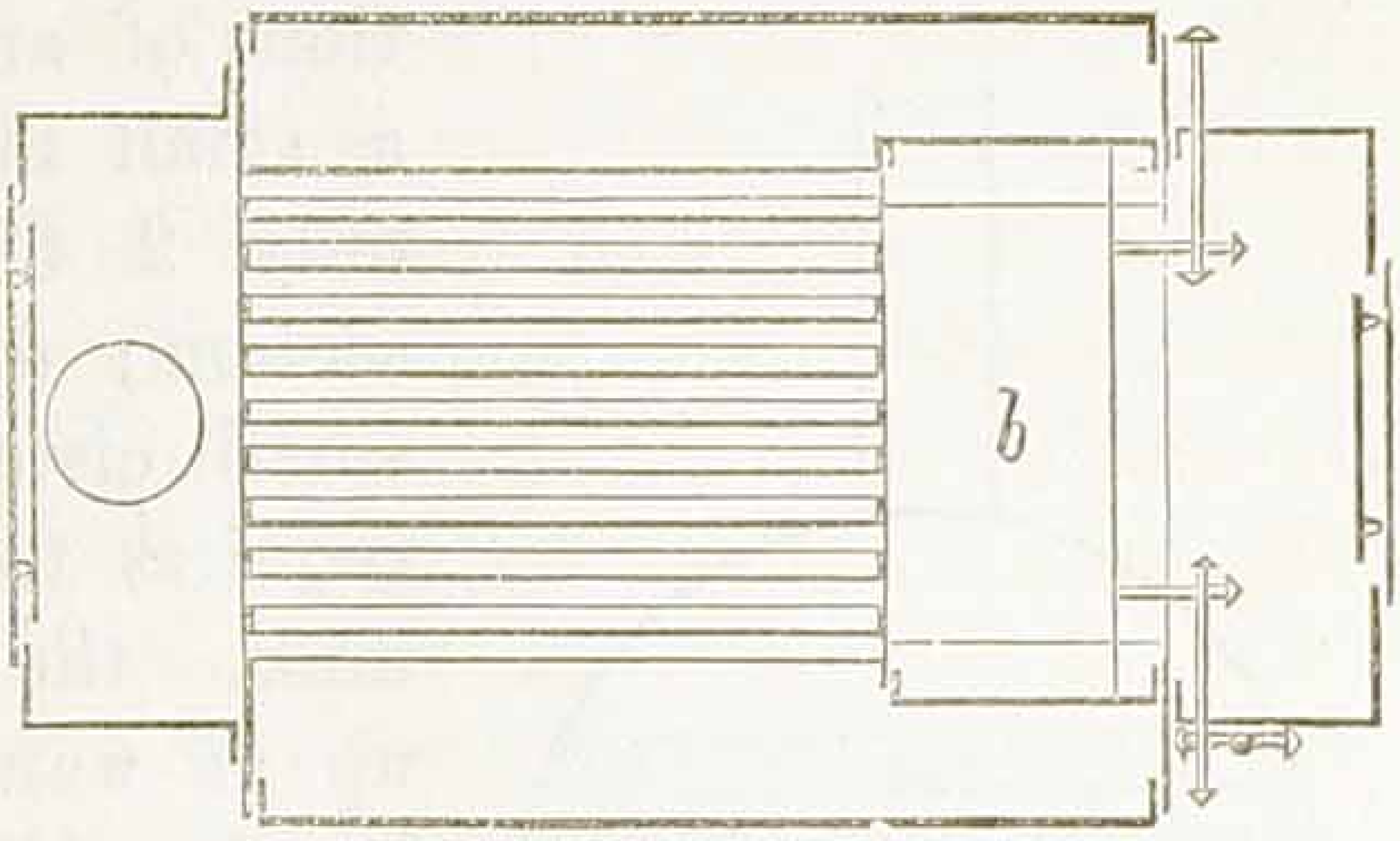


Fig. 23.

The present great expense of steam navigation throughout the world is owing to the bulky character of the fuel; in the great ocean steamers it forms 85 per cent. of the whole working expenses. It prevents any large amount of paying freight being taken.

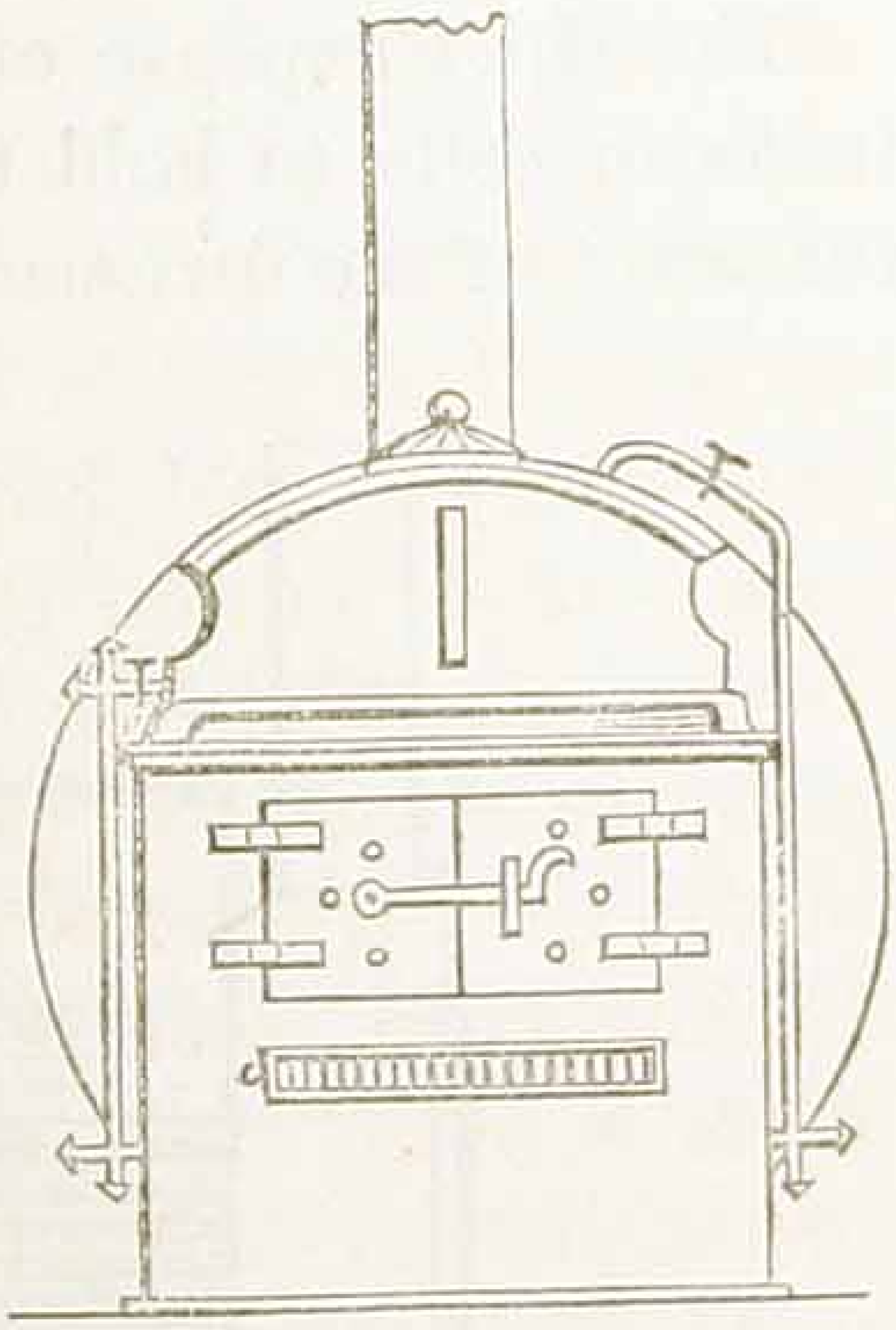


Fig. 24.

A pupil of the writer's, now one of the principal engineers of one of the Indian Railways, visited England in the spring of 1866; he came in the *Nemesis,* a steamer of 2018 tons, and 600 horse-power. Between Calcutta and Liverpool she burnt 1600 tons of coal, and the price paid was 5600*l.* or 3*l.* 10*s.* per ton; her boilers were not in very good order. She must have paid the same for fuel on her return. She had the Burmese petroleum at one end, and the Egyptian at the other,—the use of which would have told a different story as regards the expense and profits.

Figs. 23 to 26 represent a plan and elevation and two sections of an oil boiler intended for a small launch. The boiler is only 2 feet 9 inches in cross section; *b* is the oil grate, *a* the small cistern for the oil. This requires to be filled from a lower tank, the oil to be pumped up as wanted; a small register by the side of the furnace regulates the amount of oil to the grate. This can be shut off so as only to keep up steam, or instantly put in full flame; the operation is noiseless, there is no smoke, and the grate is moveable.

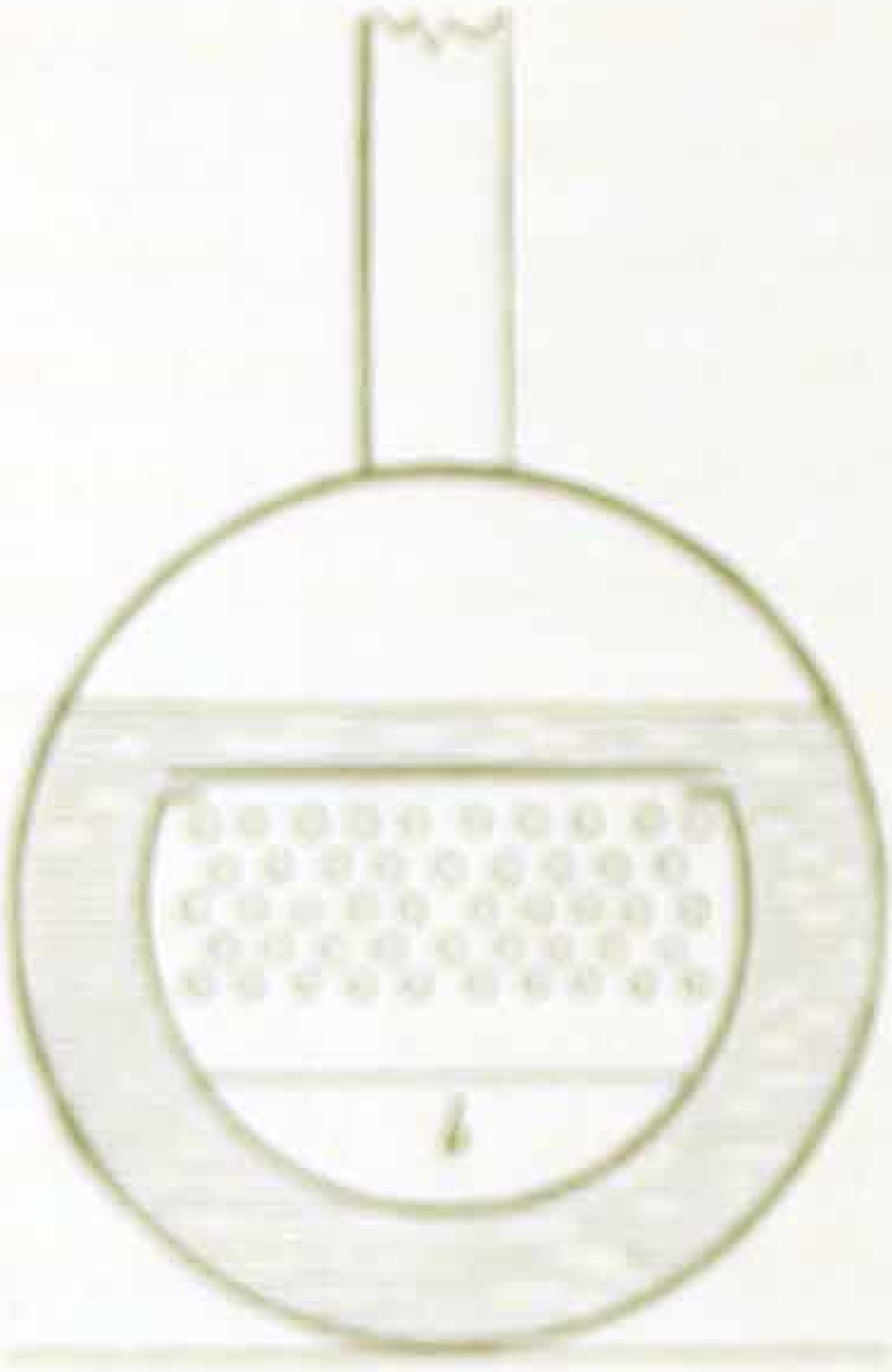


Fig. 25.

The chief expense of fitting a ship for oil-fuel is in the tanks or cells to hold the oil. These must be placed above the level of the furnace, so that the oil may fall towards it by its own weight. In the words of the Editor of the *Practical Mechanic* (March 1, 1868), "These tanks must be made vapour-tight, and supplied with valve and cock by

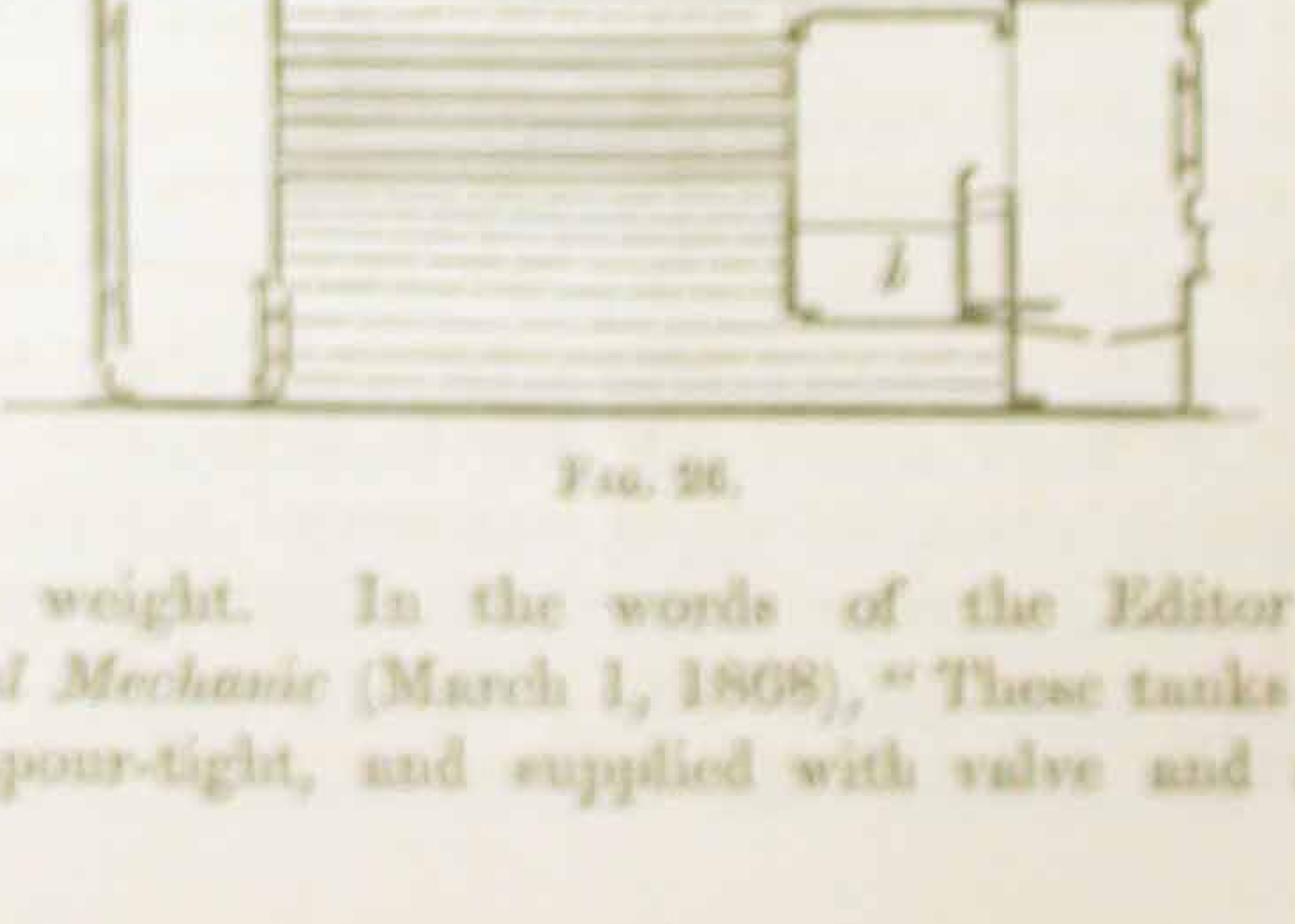


Fig. 26.

which they can be filled and emptied separately if desired, and giving the means of knowing precisely the volume, temperature, and state of the liquid within each, without access to an opening into the interior. Whether such closed cells be quite full or nearly empty, and whether their contents be churned or shaken up by the most heavily pitching or rolling ship or not, matters nothing."

An invention of any new process by which one of nature's laws is found to operate in a way to prove of great benefit to mankind, but which at first starting interferes with some of our most valued monopolies, is a task which should only have been undertaken by a person possessed of great official influence and large capital. The writer has only a moderate amount of the last and none whatever of the former, and he sincerely regrets he ever meddled with the matter; but in the words of the Duke of Somerset, given at the end of a lecture on the subject by Captain Selwyn and the writer at the Royal United Service Institution in 1865, some gratitude may be given at a future time to those by whom it was first brought forward.

In conclusion. It may appear a bold attempt, thus in a small pamphlet like the present to propose methods by which the three great nuisances of our modern civilization, the smoke and sewage of our towns, and the bulky character of our fuel at sea, can be remedied. The writer has some doubt as to how it may be received. Should it reach a second or third edition, a fuller paper may be given, treating the subjects more completely, showing the manner of combining the flues in a stack together by means of a ventilating flue of strong draught, sufficient to draw the purified smoke out of them, and finish with only one chimney on the roof, giving an elegant appearance with less brick-work.

The water remedy for smoke was first used about the year 1815. One of the patentees observes: "Many attempts have been made to purify the smoke, gases and vapours arising from the fires, stoves, or furnaces of manufactories, works and buildings, by means of water, particularly copper furnaces, but we believe without success, owing to the mode of applying the water having materially injured or destroyed the draft of the flue or chimney, and the application of water for such purposes having in many cases been abandoned." The methods then in use were to subject smoke to the action of a shower bath. Now there is a right and a wrong way of doing all things. To illustrate the right way, according to the writer's opinion as regards the water cure for smoke, let us suppose it being done on a grand scale.

Take a ten-feet length of the Niagara falls, enclose it in a large open flue, and apply to it the smoke of ten of our largest factory chimneys. If the smoke was introduced at the bottom of the fall or in front of it, it would be driven back, the draft of the smoke flues stopped, and their fires put out, it would be a failure. Introduce the smoke in the open space behind the fall, letting it enter under the lip of the rock over which the water pours, it would be a success. The smoke would fall over with the same rapidity as the water, and get well washed in the river beneath, the soot would float away, the purified vapour or gas escaping as it might, outside the fall. The smoke must go with the water current and not against it, either on a large or small scale that is the correct principle, and there is no other.

The alteration necessary to adapt it to a flue belonging to a large factory is a serious matter ; it requires study, and can only be effected by the professional man who well understands the mechanical construction required.

The two nuisances of this great metropolis, the smoke and the sewage, if brought together, would neutralize each other. If all the smut and blacks of that great aerial coal-field of London, the residuum of the 200,000 tons of coal annually used, were sent into the sewers, it would deodorize them, and it would pay, for the sewage as manure would be about doubled in value and greatly increased in quantity.

As to that other nuisance, the bulky character of coal for sea service, which prevents all the great seas being the regular and familiar pathways of mankind, the demand for it is steadily raising its price for home consumption ; the eager searching after it causes five hundred lives to be lost annually in our coal-mines, and vessels at sea are lost with all on board, like the *Amalia* and *London*, through anxiety to take it in sufficient quantity. Yet we are told that "the introduction of oil as fuel in steam navigation would be attended with a depreciation in the value of coal which would be a national calamity;" that "Petroleum is not produced to the extent of 10 per cent. of the probable consumption of coal for steam vessels belonging to this country alone." A writer in the *Times* has just observed, relative to the late Mr. Stephenson and the Suez Canal, that "eminent professional men should learn caution, and refrain from very positive predictions." The sources of nature for natural oil have only been just tapped, and distillers smile when they are told that there would not be sufficient of their present worthless residuum, even if a good price could be obtained for it.

The chapter on Liquid Fuel in this pamphlet is given merely with the intention that its present progress should be known; it has not been given to introduce any new process, and could be very largely extended. At present it may be sufficient to state that any boiler having water space below grate, can be fitted to burn oil, so as to obtain a result from two-and-a-half to three times above that given by the best coal, five times, probably, of that given by common coal. No alteration will be required, only some additional plates in lieu of the fire-bars.

Egg-end and such-like boilers require a large addition at the furnace end,—smaller chimneys in all cases being necessary. The fireplace to the locomotive requires all the coal-bars removed, and water space substituted, room only being left for the admission of air, but all the grates are supplied with hot air on the principle of the argand burner. The grates, in every instance, may be of smaller external size than that allowed for coal grates, thus permitting a larger heating surface. In all engines other than condensing engines, the exhaust steam can be used, so that no deduction need be made for the use of steam.

THE END.

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